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# FINAL REPORT

NASA Contract Number NAS5-30136

## Interpreting Measurements Obtained with the Cloud Absorption Radiometer

(NASA-CR-189241) INTERPRETING MEASUREMENTS OBTAINED WITH THE CLOUD ABSORPTION RADIOMETER Final Report (Scientific Analysis and Modelling) 78 p CSCL 04B

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Final Report

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Abstract

This contract provided programming support for the analysis of data from the Cloud Absorption Radiometer (CAR). The CAR is a multi-channel radiometer designed to measure the radiation field in the middle of an optically thick cloud (the diffusion domain). It can also measure the surface albedo and escape function. The instrument currently flies on a C-131A aircraft operated by the University of Washington. Most of this work was performed in support of the FIRE Marine Stratocumulus Intensive Field Observation program off San Diego during July 1987 although earlier flights of the CAR have also been studied. It is anticipated that the scientific results stemming from this work will be published elsewhere. This report will deal only with the software developed and provide a survey of the data received.

The theoretical foundation for this work is described in King (1981) in which a method is presented for determining the single scattering albedo of clouds at selected wavelengths in the visible and near-infrared wavelength regions. The procedure compares measurements of the ratio of the zenith to nadir propagating intensities deep within a cloud layer with radiative transfer computations of the same. Analytic formulas are derived which explicitly show the dependence of the internal intensity ratio on ground albedo, optical depth, single scattering albedo and cloud asymmetry factor. The single scattering albedo and cloud asymmetry factor enter the solution in such a way that a similarity relationship exists between these two parameters. As a result, the accuracy with which the single scattering albedo can be determined is dictated by the accuracy with which the asymmetry factor can be estimated. A method of observation is described whereby aircraft measurements of the zenith and nadir propagating intensities can be used to determine the similarity parameter as a function of wavelength. Since the fractional absorption of a cloud depends on the similarity parameter and not on the single scattering albedo and asymmetry factor separately, this poses no severe limitation to the method. An accurate knowledge of the ground albedo and total optical thickness of a cloud are unnecessary for a solution, provided one associates the wavelength for which the intensity ratio is a maximum with conservative scattering. Under this internal calibration approach, uncertainties in the ground albedo are very nearly compensated by uncertainties in the cloud optical thickness.

King et al. (1986) describes the multi-wavelength scanning radiometer that has been developed for measuring the angular distribution of scattered radiation deep within a cloud layer. The purpose of the instrument is to provide measurements from which the single scattering albedo of clouds can be derived as a function of wavelength. The radiometer has a 1° field of view and scans in the vertical plane from 5° before zenith to 5° past nadir (190° aperture). The thirteen channels of the CAR are located between 0.5 and 2.3 μm and were selected to avoid the molecular absorption bands in the near-infrared. The first seven channels of the radiometer are simultaneously and continuously sampled, while the eighth registered channel is selected from among the six channels on a filter wheel.

The processing of the CAR data is performed by a family of programs. The principal components are CARASCAN, CARANLYS, and PHIPLOT. CARASCAN ingests the raw data from the original flight tapes and reformats it. The reformated data can then be viewed using PHIPLOT to find desirable data for further study by CARANLYS. Appendix A contains program documentation, a five page example of some of the derived cloud properties (e.g. scaled optical thickness and similarity parameter), five quick look plot examples, and a listing of CARANLYS. Appendix B contains an example of a small part of a plot produced by PHIPLOT and a listing of PHIPLOT. PHIPLOT is internally documented. CARANLYS is the heart of

the data analysis. The version of CARANLYS presented in this report is the 7/5/88 version. It has 4 modes of operation.

Mode 0 performs data quality control tests for all the scan lines. It categorizes the data for each scan line into one of five groups. This quality category number (0–4) in conjunction with the plots of phi, the ratio of the of the upward and downward propagating intensities (from program PHIPLOT), and other plots produced by CARANLYS (see mode 1 below) permit the user to determine sections of data suitable for various forms of analysis including calculating the similarity parameter and surface albedo.

Mode 1 produces a variety of quick-look plots for the whole scan line range of the flight or subsets of the data if required. Modes 2 and 3 analyze selected subsets of the data for spectral surface albedo and spectral similarity parameter respectively.

Table 1–1 and 1–2 provides a log of all flights of the CAR from Jan. 12, 1984 through July 16, 1988. It includes information concerning the duration of the flight, how many data of various types were collected (columns "Total","Valid Roll", and "Diffusion Domain"), and a brief comment concerning the data quality and quantity. Table 2–1, 2–2, and 2–3 provides a more detailed summary of available diffusion domain data.

Flight log (9/14/88)

| Flight | Date | Aircraft | Start of Scan | | End of Scan | | Number of | Total | Valid | Diffusion |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Scan | Time | Scan | Time | Scan Lines | | Roll | Domain |
| 1136 | 12 Jan 1984 | B-23 | 1355 | 12:10:02 | 8907 | 13:21:02 | 3335 | 3335 | 2498 | 99 |
| 1137 | 12 Jan 1984 | B-23 | 503 | 14:42:01 | 2442 | 15:00:25 | 1489 | 1489 | 1109 | 297 |
| 1138 | 13 Jan 1984 | B-23 | 605 | 14:16:46 | 4898 | 14:59:54 | 2994 | 2994 | 2179 | 312 |
| 1139 | 20 Jan 1984 | B-23 | 4873 | 12:15:25 | 10573 | 13:13:04 | 4470 | 4470 | 3220 | 283 |
| 1152 | 29 May 1984 | B-23 | 303 | 11:22:59 | 13274 | 13:33:32 | 1442 | | | |
| | | | 369 | 13:38:44 | 3590 | 14:11:19 | 2806 | 4248 | 2375 | 110 |
| 1153 | 30 May 1984 | B-23 | 313 | 10:11:29 | 10335 | 11:49:14 | 2003 | 2003 | 965 | 344 |
| 1160 | 6 May 1985 | C-131A | 1418 | 12:31:17 | 5521 | 13:12:08 | 620 | 620 | 342 | 113 |
| 1165 | 24 May 1985 | C-131A | 4464 | 11:59:57 | 8160 | 12:36:50 | 1998 | 1998 | 105 | 9 |
| 1166 | 28 May 1985 | C-131A | 4895 | 13:02:59 | 8269 | 13:36:35 | 1790 | 1790 | 364 | 26 |
| 1167 | 29 May 1985 | C-131A | 187 | 12:19:45 | 10018 | 13:57:45 | 961 | 961 | 597 | 151 |
| 1170 | 19 Jun 1985 | C-131A | 1338 | 12:04:37 | 11832 | 13:50:24 | 2660 | 2660 | 1594 | 669 |
| 1174 | 17 Jul 1985 | C-131A | 42 | 11:40:53 | 8349 | 13:03:37 | 3316 | 3316 | 2782 | 116 |
| 1207 | 30 Oct 1985 | C-131A | 5179 | 12:08:12 | 7272 | 12:29:32 | 1045 | 1045 | 471 | 314 |
| 1252 | 4 Jun 1986 | C-131A | 45 | 12:53:20 | 6991 | 14:03:00 | 4845 | 4845 | 4701 | 1123 |
| 1253 | 5 Jun 1986 | C-131A | 7 | 11:50:49 | 13587 | 14:06:37 | 4143 | 4143 | 3202 | 692 |
| 1264 | 22 Jul 1986 | C-131A | 2969 | 11:23:18 | 7461 | 12:07:44 | 3057 | | | |
| | | | 1 | 12:26:43 | 3188 | 12:58:20 | 2131 | 5188 | 3590 | 1717 |
| 1296 | 29 Jun 1987 | C-131A | 1 | 13:28:00 | 12383 | 15:36:10 | 4414 | 4414 | 4023 | 3 |
| 1297 | 30 Jun 1987 | C-131A | 1 | 10:49:28 | 16835 | 13:43:28 | 8852 | 8852 | 7772 | 987 |
| 1298 | 2 Jul 1987 | C-131A | 1330 | 7:59:54 | 7031 | 8:57:41 | 2396 | | | |
| | | | 731 | 9:11:50 | 11915 | 11:05:28 | 7032 | 9428 | 7546 | 1133 |
| 1299 | 5 Jul 1987 | C-131A | 864 | 8:37:41 | 3866 | 9:08:30 | 2852 | | | |
| | | | 1 | 9:12:19 | 17358 | 12:10:29 | 13757 | 16609 | 15752 | 990 |
| 1300 | 7 Jul 1987 | C-131A | 44 | 9:20:27 | 22604 | 13:08:51 | 14509 | 14509 | 13435 | 2256 |
| 1301 | 10 Jul 1987 | C-131A | 55 | 7:59:06 | 23697 | 12:01:35 | 17866 | 17866 | 16676 | 6930 |
| 1303 | 13 Jul 1987 | C-131A | 126 | 9:44:33 | 22451 | 13:32:55 | 17396 | 17396 | 16399 | 1340 |
| 1308 | 16 Jul 1987 | C-131A | 21 | 8:45:31 | 3448 | 9:20:41 | 3428 | | | |
| | | | 14 | 9:29:02 | 23654 | 13:31:45 | 16516 | 19944 | 16914 | 6646 |

Table 1-1

Flight log (9/14/88)

| Flight | Date | Aircraft | Useful Data | Comments |
|---|---|---|---|---|
| 1136 | 12 Jan 1984 | B-23 | Yes | Possibly some useful data near Olympia |
| 1137 | 12 Jan 1984 | B-23 | Yes | Brief encounter with clouds, CAR wet, return to Paine Field |
| 1138 | 13 Jan 1984 | B-23 | Yes | Eastern Washington - nice diffusion domain |
| 1139 | 20 Jan 1984 | B-23 | Yes | Orographically forced Sc in eastern WA (Beijing analysis) |
| 1152 | 29 May 1984 | B-23 | No | Hoquium/Astoria under Ci shield - zenith saturated due to solar zenith angle |
| 1153 | 30 May 1984 | B-23 | No | Mixed phase stratocumulus cloud over Puget Sound (JTech data series) |
| 1160 | 6 May 1985 | C-131A | No | Glaciated Cb, Cu and inhomogeneous Sc - engineering test flight with C-131A |
| 1165 | 24 May 1985 | C-131A | No | Multilayered and broken cloud over ocean |
| 1166 | 28 May 1985 | C-131A | No | Cloud near Tatoosh Island required banking aircraft too much |
| 1167 | 29 May 1985 | C-131A | No | Brief sections with good CAR data, tape recorder turned on and off too often |
| 1170 | 19 Jun 1985 | C-131A | Yes | Single layer offshore Sc, 1300 ft thick, frequent saturation of zenith intensity |
| 1174 | 17 Jul 1985 | C-131A | Yes | Single layer Sc off Hoquium, clouds marginally thick enough |
| 1207 | 30 Oct 1985 | C-131A | Yes | Iced flat-topped Cb near Tatoosh Island and Strait of Juan de Fuca |
| 1252 | 4 Jun 1986 | C-131A | Yes | Extensive Sc with embedded Cu - some saturation of zenith intensity |
| 1253 | 5 Jun 1986 | C-131A | Yes | Reasonably uniform Sc off Hoquium, embedded Cu at one end of run |
| 1264 | 22 Jul 1986 | C-131A | Yes | Multiple passes and turns in Sc offshore of Willapa Hills |
| 1296 | 29 Jun 1987 | C-131A | No | First FIRE Sc mission, clouds too thin for diffusion domain (late flight) |
| 1297 | 30 Jun 1987 | C-131A | Yes | Diffusion domain, interesting data above clouds, haze layer near San Diego |
| 1298 | 2 Jul 1987 | C-131A | Yes | Diffusion domain in cloud, excellent escape function below cloud, "Negative ship tracks" |
| 1299 | 5 Jul 1987 | C-131A | Yes | C-130 coordinated wingtip intercomparison, excellent diffusion domain |
| 1300 | 7 Jul 1987 | C-131A | Yes | Landsat-4 and ER-2 coordination, 125 km stretch of diffusion domain en route |
| 1301 | 10 Jul 1987 | C-131A | Yes | ER-2 coordination, ship tracks en route, excellent diffusion domain |
| 1303 | 13 Jul 1987 | C-131A | Yes | C-130 and ER-2 coordination, excellent diffusion domain and transmission |
| 1308 | 16 Jul 1987 | C-131A | Yes | Landsat-4 and ER-2 coordination, excellent diffusion domain during intercomparison |

Table 1-2

Scan lines containing diffusion domain data

| Flight | Date | Aircraft | Scan Range | Comments |
|---|---|---|---|---|
| 1136 | 12 Jan 1984 | B-23 | 3292-3520 | |
| | | | 4851-5148 | |
| 1137 | 12 Jan 1984 | B-23 | 663-845 | |
| | | | 1465-1695 | |
| | | | 1927-2324 | |
| 1138 | 13 Jan 1984 | B-23 | 941-1182 | |
| | | | 1839-2643 | |
| 1139 | 20 Jan 1984 | B-23 | 5979-6254 | Beijing analysis |
| | | | 8861-8947 | |
| | | | 9272-9390 | |
| 1152 | 29 May 1984 | B-23 | — | |
| 1153 | 30 May 1984 | B-23 | 314-637 | |
| 1160 | 6 May 1985 | C-131A | — | |
| 1165 | 24 May 1985 | C-131A | — | |
| 1166 | 28 May 1985 | C-131A | — | |
| 1167 | 29 May 1985 | C-131A | — | |
| 1170 | 19 Jun 1985 | C-131A | 10238-10547 | |
| | | | 10743-10899 | |
| | | | 11051-11208 | |
| 1174 | 17 Jul 1985 | C-131A | 4338-4862 | |
| 1207 | 30 Oct 1985 | C-131A | 5327-5421 | Intensity ratio ~ 0.90 |
| | | | 6045-6320 | Intensity ratio ~ 0.90 |
| | | | 6824-7195 | Intensity ratio ~ 0.90 |
| 1252 | 4 Jun 1986 | C-131A | 1890-2583 | Some saturation of zenith intensity after scan 2583 |
| | | | 4519-5020 | Some saturation of zenith intensity after scan 5020 |
| | | | 5756-6480 | Some saturation of zenith intensity before scan 6000 |
| 1253 | 5 Jun 1986 | C-131A | 405-563 | |
| | | | 2847-3437 | |
| | | | 6740-7288 | |
| | | | 10457-10563 | |

Table 2-1

Scan lines containing diffusion domain data

| Flight | Date | Aircraft | Scan Range | Comments |
|---|---|---|---|---|
| 1253 | 5 Jun 1986 | C-131A | 11583-11698 | |
| 1264 | 22 Jul 1986 | C-131A | 3157-3848 | Some saturation of zenith intensity before scan 3157 |
| | | | 4608-4956 | |
| | | | 5183-5665 | |
| | | | 6853-6996 | Intensity ratio ~ 0.6 |
| | | | 41-514 | Scan number restarted after 7461 |
| | | | 2202-3156 | Some saturation of zenith intensity after scan 3156 |
| 1296 | 29 Jun 1987 | C-131A | — | |
| 1297 | 30 Jun 1987 | C-131A | 5-848 | Nice diffusion domain but saturation of filter wheel channels |
| | | | 7353-7542 | Nice diffusion domain but saturation of filter wheel channels |
| | | | 8054-8477 | Nice diffusion domain but saturation of filter wheel channels |
| | | | 8982-9152 | Nice diffusion domain but saturation of filter wheel channels |
| | | | 13446-13831 | Nice diffusion domain but saturation of filter wheel channels |
| 1298 | 2 Jul 1987 | C-131A | 1330-1690 | |
| | | | 6325-6911 | Excellent diffusion domain, some saturation before scan 6325 |
| | | | 909-1568 | Scan number restarted after 6912 |
| | | | 8168-8561 | |
| 1299 | 5 Jul 1987 | C-131A | 2791-3318 | |
| | | | 15455-16008 | |
| 1300 | 7 Jul 1987 | C-131A | 1451-4210 | Extensive diffusion domain |
| 1301 | 10 Jul 1987 | C-131A | 4847-7885 | Includes ship tracks |
| | | | 8626-10506 | ER-2 Flight line #2 |
| | | | 11340-12740 | |
| | | | 14951-15951 | |
| | | | 16805-17240 | |
| | | | 18053-19588 | |
| 1303 | 13 Jul 1987 | C-131A | 2422-4167 | |
| | | | 8153-8604 | |
| 1308 | 16 Jul 1987 | C-131A | 2413-3435 | |
| | | | 1546-5250 | Scan number restarted after 3448 |

Table 2-2

Scan lines containing diffusion domain data

| Flight | Date | Aircraft | Scan Range | Comments |
|---|---|---|---|---|
| 1308 | 16 Jul 1987 | C-131A | 7315-9510 | |
| | | | 11773-12946 | |
| | | | 13445-14494 | |
| | | | 15332-16380 | |

Table 2-3

References

King, M. D., 1981: A Method for Determining the Single Scattering Albedo of Clouds Through Observation of the Internal Scattered Radiation Field. J. Atmos. Sci., **38**, 2031-2044.

____, M. G. Strange, P. Leone and L. R. Blaine, 1986: Multiwavelength Scanning Radiometer for Airborne Meaurements of Scattered Radiation within Clouds. J Atmos. Oceanic Tech., **3**, 513-522.

# Appendix A

# CARANLYS

Program Documentation

Example of Some Results

Five Quick Look Plot Examples

Program Listing

Program name: CARANLYS

Authors: Michael D. King
Howard G. Meyer

Date written: January 1985 (revised April 1988)

Reference: King, M. D., 1981: *J. Atmos. Sci.*, **38**, 2031-2044.
King, M. D., and Harshvardhan, 1986: *J. Atmos. Sci.*, **43**, 784-801.
King, M. D., M. G. Strange, P. Leone and L. R. Blaine, 1986: *J. Atmos. Oceanic Tech.*, **3**, 513-522.

Objective: To determine the similarity parameter of clouds from internal scattered radiation measurements.

# I. Procedure

A. Run program CARANLYS following program CARASCAN, which writes a data tape containing data from the active scan portion of each scan line, together with the time, aircraft roll, filter wheel position, condensation status indicator, thermistor temperatures, and other housekeeping data from the Cloud Absorption Radiometer. Determine the surface albedo and standard deviations for each channel of the CAR by running program CARANLYS once for a section of data beneath a cloud. The control card images and deck structure for running program CARANLYS are contained in Figure 62.

B. The input data file should have the following form:

```
MODE
WVL(1)        ...     WVL(13)
CALSLP(1)     ...     CALSLP(13)
CALINT(1)     ...     CALINT(13)
AG0(1)        ...     AG0(13)
SIGAG(1)      ...     SIGAG(13)
IPRINT
ISCAN1(1)     ISCAN2(1)
.             .
.             .
.             .
ISCAN1(N)     ISCAN2(N)
```

where,

MODE = Mode of data processing
0 Perform quality control tests for all scan lines
1 Create plots for all scan lines and selected channels

2 Derive spectral ground albedo and plot results
3 Derive spectral similarity parameter using individual scan lines and plot results

| | | |
|---|---|---|
| WVL | = | Array of wavelengths in μm |
| CALSLP | = | Array of calibration slopes in mW $cm^{-2}$ $\mu m^{-1}$ $sr^{-1}$ $V^{-1}$ |
| CALINT | = | Array of calibration intercepts in mW $cm^{-2}$ $\mu m^{-1}$ $sr^{-1}$ |
| AG0 | = | Array of ground albedo $A_g$ |
| SIGAG | = | Array of ground albedo standard deviations |
| IPRINT | = | Dummy variable for input compatibility with program PHIPLOT |
| ISCAN1 | = | Array of first scan lines to be processed |
| ISCAN2 | = | Array of last scan lines to be processed |

The formats of the input card images are:

cards 1–5 – 7F10.0
card 6–N – 7I10

C. The output consists of the ratio of the nadir to zenith intensities for each scan and channel of the CAR for the specified scan lines, together with the scaled optical thickness between the aircraft flight level and the base of the cloud $t = [(1-g)(\tau_c-\tau)]$ and the similarity parameter $s = [(1-\omega_0)/(1-\omega_0 g)]^{1/2}$ at 12 of 13 channels of the CAR. Standard deviations of $t$ and $s(\lambda)$ are also calculated.

II. Comments

A. Program dimension statements valid for 20000 scan lines, 13 wavelengths, 50 segments of data, and up to 1000 data points on an individual plot. These values can readily be altered in the parameter statement of the main program.

Optical thickness and similarity parameter for 10 July 1987 (931-941 PDT)

Channel 3
Wavelength: 0.7435 μm
Asymmetry factor: 0.84317

Flight Number: 1301
Ground albedo: 0.0634 +/- 0.0078

| Scan | Distance | Time | Intensity (-1) | Intensity (1) | Intensity ratio | Scaled Optical depth | Optical depth | s(0.7435) |
|---|---|---|---|---|---|---|---|---|
| 9019 | 45.88 | 9:31:12 | 5.9491 | 14.5743 | 0.4082 | 1.6171 | 10.31 | 0.0580 |
| 9021 | 45.97 | 9:31:14 | 7.5492 | 15.0424 | 0.5019 | 2.2760 | 14.51 | 0.0479 |
| 9022 | 46.02 | 9:31:14 | 7.6674 | 17.4604 | 0.4391 | 1.8557 | 11.83 | 0.0763 |
| 9023 | 46.07 | 9:31:15 | 7.7835 | 17.5407 | 0.4437 | 1.8833 | 12.01 | 0.0740 |
| 9031 | 46.47 | 9:31:20 | 8.6833 | 16.2155 | 0.5355 | 2.6115 | 16.65 | 0.0537 |
| 9032 | 46.52 | 9:31:20 | 8.9527 | 17.1064 | 0.5234 | 2.4970 | 15.92 | 0.0555 |
| 9033 | 46.56 | 9:31:21 | 9.2267 | 17.6159 | 0.5238 | 2.4936 | 15.90 | 0.0534 |
| 9034 | 46.61 | 9:31:22 | 9.3075 | 18.0863 | 0.5146 | 2.4362 | 15.53 | 0.0616 |
| 9035 | 46.66 | 9:31:22 | 9.3832 | 17.8124 | 0.5268 | 2.5311 | 16.14 | 0.0556 |
| 9036 | 46.71 | 9:31:23 | 9.4180 | 17.5727 | 0.5359 | 2.6335 | 16.79 | 0.0577 |
| 9037 | 46.76 | 9:31:23 | 9.1880 | 17.4603 | 0.5262 | 2.5343 | 16.16 | 0.0577 |
| 9038 | 46.81 | 9:31:24 | 9.0714 | 16.3691 | 0.5542 | 2.8162 | 17.96 | 0.0544 |
| 9039 | 46.86 | 9:31:25 | 8.8387 | 16.3295 | 0.5413 | 2.6785 | 17.08 | 0.0552 |
| 9040 | 46.91 | 9:31:25 | 8.7568 | 16.2473 | 0.5390 | 2.6108 | 16.65 | 0.0441 |
| 9041 | 46.96 | 9:31:26 | 8.5269 | 16.5256 | 0.5160 | 2.4211 | 15.44 | 0.0539 |
| 9042 | 47.01 | 9:31:27 | 8.6042 | 17.0338 | 0.5051 | 2.3422 | 14.93 | 0.0601 |
| 9043 | 47.06 | 9:31:27 | 8.4874 | 17.3838 | 0.4882 | 2.2005 | 14.03 | 0.0622 |
| 9044 | 47.11 | 9:31:28 | 8.5998 | 17.5743 | 0.4893 | 2.2343 | 14.25 | 0.0695 |
| 9045 | 47.15 | 9:31:28 | 8.3310 | 17.3043 | 0.4814 | 2.1486 | 13.70 | 0.0639 |
| 9046 | 47.20 | 9:31:29 | 8.5255 | 16.6430 | 0.5123 | 2.4195 | 15.43 | 0.0631 |
| 9047 | 47.25 | 9:31:30 | 8.4869 | 16.4468 | 0.5160 | 2.4618 | 15.70 | 0.0645 |
| 9048 | 47.30 | 9:31:30 | 8.5991 | 16.2476 | 0.5293 | 2.5442 | 16.22 | 0.0526 |
| 9049 | 47.35 | 9:31:31 | 8.6421 | 16.0158 | 0.5396 | 2.6165 | 16.68 | 0.0439 |
| 9050 | 47.40 | 9:31:32 | 8.5652 | 16.0188 | 0.5347 | 2.6160 | 16.68 | 0.0567 |
| 9051 | 47.45 | 9:31:32 | 8.4854 | 16.0941 | 0.5272 | 2.5050 | 15.97 | 0.0471 |

Optical thickness and similarity parameter for 10 July 1987 (931-941 PDT)

Channel 3
Wavelength: 0.7435 µm
Asymmetry factor: 0.84317

Flight Number: 1301
Ground albedo: 0.0634 +/- 0.0078

| Scan | Distance | Time | Intensity (-1) | Intensity (1) | Intensity ratio | Scaled Optical depth | Optical depth | s(0.7435) |
|---|---|---|---|---|---|---|---|---|
| 9052 | 47.50 | 9:31:33 | 8.4802 | 16.3237 | 0.5195 | 2.4377 | 15.54 | 0.0490 |
| 9053 | 47.55 | 9:31:33 | 8.5661 | 16.3323 | 0.5245 | 2.5043 | 15.97 | 0.0545 |
| 9054 | 47.60 | 9:31:34 | 8.6058 | 16.2949 | 0.5281 | 2.5469 | 16.24 | 0.0562 |
| 9055 | 47.65 | 9:31:35 | 8.6440 | 16.3711 | 0.5280 | 2.5678 | 16.37 | 0.0614 |
| 9056 | 47.70 | 9:31:35 | 8.6021 | 16.0938 | 0.5345 | 2.5918 | 16.53 | 0.0513 |
| 9057 | 47.75 | 9:31:36 | 8.4084 | 15.7444 | 0.5341 | 2.5752 | 16.42 | 0.0480 |
| 9058 | 47.79 | 9:31:36 | 8.5250 | 15.6666 | 0.5442 | 2.6918 | 17.16 | 0.0513 |
| 9059 | 47.84 | 9:31:37 | 8.4478 | 15.6276 | 0.5406 | 2.6456 | 16.87 | 0.0490 |
| 9060 | 47.89 | 9:31:38 | 8.2877 | 15.6621 | 0.5292 | 2.5520 | 16.27 | 0.0549 |
| 9061 | 47.94 | 9:31:38 | 8.3310 | 15.6681 | 0.5317 | 2.5533 | 16.28 | 0.0484 |
| 9062 | 47.99 | 9:31:39 | 8.3710 | 15.4326 | 0.5424 | 2.6751 | 17.06 | 0.0516 |
| 9063 | 48.04 | 9:31:40 | 8.3689 | 15.3547 | 0.5450 | 2.6982 | 17.20 | 0.0505 |
| 9064 | 48.09 | 9:31:40 | 8.3650 | 15.3100 | 0.5464 | 2.6972 | 17.20 | 0.0468 |
| 9065 | 48.14 | 9:31:41 | 8.2920 | 15.2379 | 0.5442 | 2.7029 | 17.23 | 0.0538 |
| 9066 | 48.19 | 9:31:41 | 8.2148 | 15.1990 | 0.5405 | 2.6551 | 16.93 | 0.0517 |
| 9067 | 48.24 | 9:31:42 | 8.2129 | 15.1602 | 0.5417 | 2.6525 | 16.91 | 0.0478 |
| 9068 | 48.29 | 9:31:43 | 8.1702 | 15.1539 | 0.5391 | 2.6294 | 16.77 | 0.0488 |
| 9069 | 48.34 | 9:31:43 | 8.1741 | 15.2376 | 0.5364 | 2.5808 | 16.46 | 0.0426 |
| 9070 | 48.38 | 9:31:44 | 8.1754 | 15.3158 | 0.5338 | 2.5582 | 16.31 | 0.0439 |
| 9071 | 48.43 | 9:31:44 | 8.2129 | 15.4329 | 0.5322 | 2.5327 | 16.15 | 0.0349 |
| 9072 | 48.48 | 9:31:45 | 8.1300 | 15.6220 | 0.5204 | 2.4849 | 15.84 | 0.0597 |
| 9073 | 48.53 | 9:31:46 | 8.1745 | 15.8232 | 0.5166 | 2.4220 | 15.44 | 0.0525 |
| 9074 | 48.58 | 9:31:46 | 8.1755 | 16.0186 | 0.5104 | 2.3611 | 15.06 | 0.0514 |
| 9075 | 48.63 | 9:31:47 | 8.1359 | 16.1354 | 0.5042 | 2.3015 | 14.68 | 0.0497 |
| 9076 | 48.68 | 9:31:48 | 8.0128 | 15.7393 | 0.5091 | 2.3571 | 15.03 | 0.0551 |

Optical thickness and similarity parameter for 10 July 1987 (931-941 PDT)

Channel 3
Wavelength: 0.7435 μm
Asymmetry factor: 0.84317

Flight Number: 1301
Ground albedo: 0.0634 +/- 0.0078

| Scan | Distance | Time | Intensity (-1) | Intensity (1) | Intensity ratio | Scaled Optical depth | Optical depth | s(0.7435) |
|---|---|---|---|---|---|---|---|---|
| 9077 | 48.73 | 9:31:48 | 7.9406 | 15.2379 | 0.5211 | 2.4458 | 15.60 | 0.0468 |
| 9078 | 48.78 | 9:31:49 | 7.8643 | 15.0845 | 0.5214 | 2.4917 | 15.89 | 0.0591 |
| 9079 | 48.83 | 9:31:49 | 7.7866 | 15.2790 | 0.5096 | 2.3401 | 14.92 | 0.0464 |
| 9080 | 48.88 | 9:31:50 | 7.7051 | 15.1960 | 0.5070 | 2.3181 | 14.78 | 0.0467 |
| 9081 | 48.93 | 9:31:51 | 7.5512 | 15.1606 | 0.4981 | 2.2567 | 14.39 | 0.0529 |
| 9082 | 48.98 | 9:31:51 | 7.3560 | 14.9648 | 0.4915 | 2.1758 | 13.87 | 0.0422 |
| 9083 | 49.02 | 9:31:52 | 7.3158 | 14.8454 | 0.4928 | 2.2140 | 14.12 | 0.0536 |
| 9084 | 49.07 | 9:31:52 | 7.4299 | 14.7262 | 0.5045 | 2.3362 | 14.90 | 0.0599 |
| 9085 | 49.12 | 9:31:53 | 7.3940 | 14.6525 | 0.5046 | 2.3155 | 14.76 | 0.0533 |
| 9086 | 49.17 | 9:31:54 | 7.3943 | 14.6907 | 0.5033 | 2.2953 | 14.64 | 0.0503 |
| 9087 | 49.22 | 9:31:54 | 7.3164 | 14.6918 | 0.4980 | 2.2528 | 14.36 | 0.0516 |
| 9088 | 49.27 | 9:31:55 | 7.3081 | 14.6832 | 0.4977 | 2.2485 | 14.34 | 0.0509 |
| 9089 | 49.32 | 9:31:56 | 7.2381 | 14.6532 | 0.4940 | 2.2311 | 14.23 | 0.0561 |
| 9090 | 49.37 | 9:31:56 | 7.2002 | 14.5751 | 0.4940 | 2.2109 | 14.10 | 0.0485 |
| 9091 | 49.42 | 9:31:57 | 7.0819 | 14.6141 | 0.4846 | 2.1498 | 13.71 | 0.0551 |
| 9092 | 49.47 | 9:31:57 | 7.0755 | 14.7231 | 0.4806 | 2.1287 | 13.57 | 0.0594 |
| 9093 | 49.52 | 9:31:58 | 7.1990 | 14.8871 | 0.4836 | 2.1337 | 13.61 | 0.0515 |
| 9094 | 49.57 | 9:31:59 | 7.3558 | 14.9641 | 0.4916 | 2.1949 | 14.00 | 0.0503 |
| 9095 | 49.61 | 9:31:59 | 7.4331 | 15.0039 | 0.4954 | 2.2339 | 14.24 | 0.0528 |
| 9096 | 49.66 | 9:32:00 | 7.3874 | 15.2308 | 0.4850 | 2.1553 | 13.74 | 0.0558 |
| 9097 | 49.71 | 9:32:00 | 7.4705 | 15.3929 | 0.4853 | 2.1594 | 13.77 | 0.0568 |
| 9098 | 49.76 | 9:32:01 | 7.5114 | 15.3928 | 0.4880 | 2.1795 | 13.90 | 0.0557 |
| 9099 | 49.81 | 9:32:02 | 7.5101 | 15.3147 | 0.4904 | 2.1782 | 13.89 | 0.0475 |
| 9100 | 49.86 | 9:32:02 | 7.4675 | 14.9980 | 0.4979 | 2.2530 | 14.37 | 0.0520 |
| 9101 | 49.91 | 9:32:03 | 7.4349 | 14.8119 | 0.5020 | 2.2955 | 14.64 | 0.0545 |

Optical thickness and similarity parameter for 10 July 1987 (931-941 PDT)

Channel 3
Wavelength: 0.7435 μm
Asymmetry factor: 0.84317

Flight Number: 1301
Ground albedo: 0.0634 +/- 0.0078

| Scan | Distance | Time | Intensity (-1) | Intensity (1) | Intensity ratio | Scaled Optical depth | Optical depth | s(0.7435) |
|---|---|---|---|---|---|---|---|---|
| 9102 | 49.96 | 9:32:04 | 7.3970 | 14.9287 | 0.4955 | 2.2356 | 14.25 | 0.0531 |
| 9103 | 50.01 | 9:32:04 | 7.2784 | 15.2020 | 0.4788 | 2.1382 | 13.63 | 0.0677 |
| 9104 | 50.06 | 9:32:05 | 7.0790 | 15.3517 | 0.4611 | 1.9932 | 12.71 | 0.0662 |
| 9105 | 50.11 | 9:32:05 | 7.1991 | 15.1206 | 0.4761 | 2.0636 | 13.16 | 0.0470 |
| 9106 | 50.16 | 9:32:06 | 7.1998 | 14.8475 | 0.4849 | 2.1348 | 13.61 | 0.0478 |
| 9107 | 50.21 | 9:32:07 | 7.1988 | 14.7702 | 0.4874 | 2.1726 | 13.85 | 0.0550 |
| 9108 | 50.25 | 9:32:07 | 7.1947 | 14.7638 | 0.4873 | 2.1906 | 13.97 | 0.0615 |
| 9109 | 50.30 | 9:32:08 | 7.1989 | 14.8871 | 0.4836 | 2.1541 | 13.74 | 0.0597 |
| 9110 | 50.35 | 9:32:09 | 7.1991 | 15.0430 | 0.4786 | 2.1182 | 13.51 | 0.0615 |
| 9111 | 50.40 | 9:32:09 | 7.2774 | 15.1984 | 0.4788 | 2.1011 | 13.40 | 0.0542 |
| 9112 | 50.45 | 9:32:10 | 7.2739 | 15.1951 | 0.4787 | 2.1192 | 13.51 | 0.0615 |
| 9113 | 50.50 | 9:32:10 | 7.2787 | 15.2383 | 0.4777 | 2.1219 | 13.53 | 0.0654 |
| 9114 | 50.55 | 9:32:11 | 7.1985 | 15.3949 | 0.4676 | 2.0292 | 12.94 | 0.0607 |
| 9115 | 50.60 | 9:32:12 | 7.1218 | 15.5118 | 0.4591 | 1.9636 | 12.52 | 0.0602 |
| 9116 | 50.65 | 9:32:12 | 7.0406 | 15.6241 | 0.4506 | 1.8994 | 12.11 | 0.0592 |
| 9117 | 50.70 | 9:32:13 | 6.9643 | 15.5481 | 0.4479 | 1.8816 | 12.00 | 0.0599 |
| 9118 | 50.75 | 9:32:13 | 7.0034 | 15.1988 | 0.4608 | 1.9907 | 12.69 | 0.0662 |
| 9119 | 50.80 | 9:32:14 | 6.9258 | 14.9636 | 0.4628 | 1.9881 | 12.68 | 0.0587 |
| 9120 | 50.84 | 9:32:15 | 6.9578 | 14.9966 | 0.4640 | 1.9842 | 12.65 | 0.0532 |
| 9121 | 50.89 | 9:32:15 | 6.9640 | 15.0418 | 0.4630 | 1.9873 | 12.67 | 0.0579 |
| 9122 | 50.94 | 9:32:16 | 6.9644 | 15.0808 | 0.4618 | 1.9716 | 12.57 | 0.0548 |
| 9123 | 50.99 | 9:32:17 | 7.0810 | 15.0025 | 0.4720 | 2.0602 | 13.14 | 0.0594 |
| 9124 | 51.04 | 9:32:17 | 7.0383 | 14.9209 | 0.4717 | 2.0382 | 13.00 | 0.0510 |
| 9125 | 51.09 | 9:32:18 | 6.9680 | 14.8505 | 0.4692 | 2.0223 | 12.89 | 0.0526 |
| 9126 | 51.14 | 9:32:18 | 6.9284 | 14.8506 | 0.4665 | 2.0217 | 12.89 | 0.0610 |

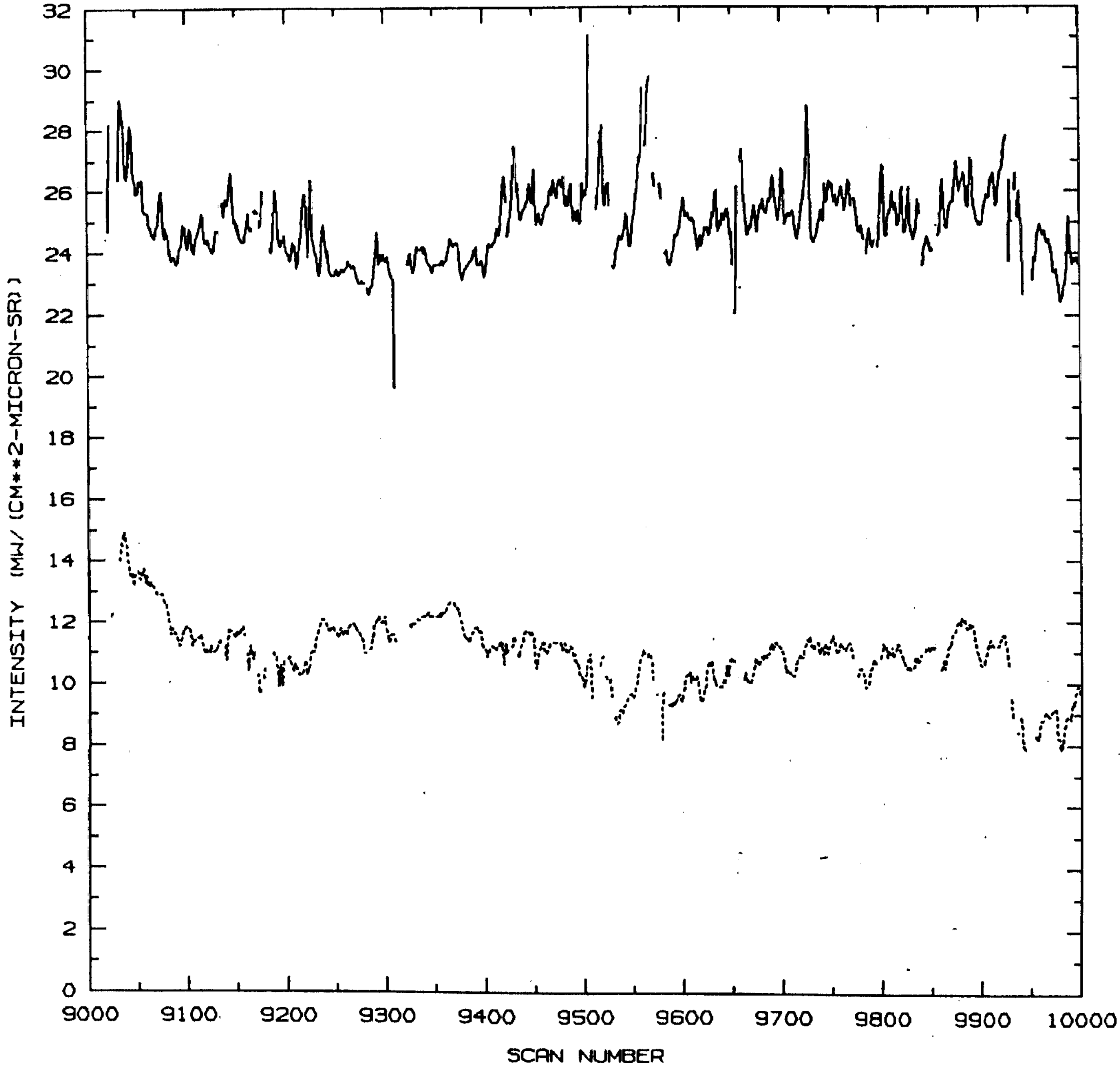
Optical thickness and similarity parameter for 10 July 1987 (931-941 PDT)

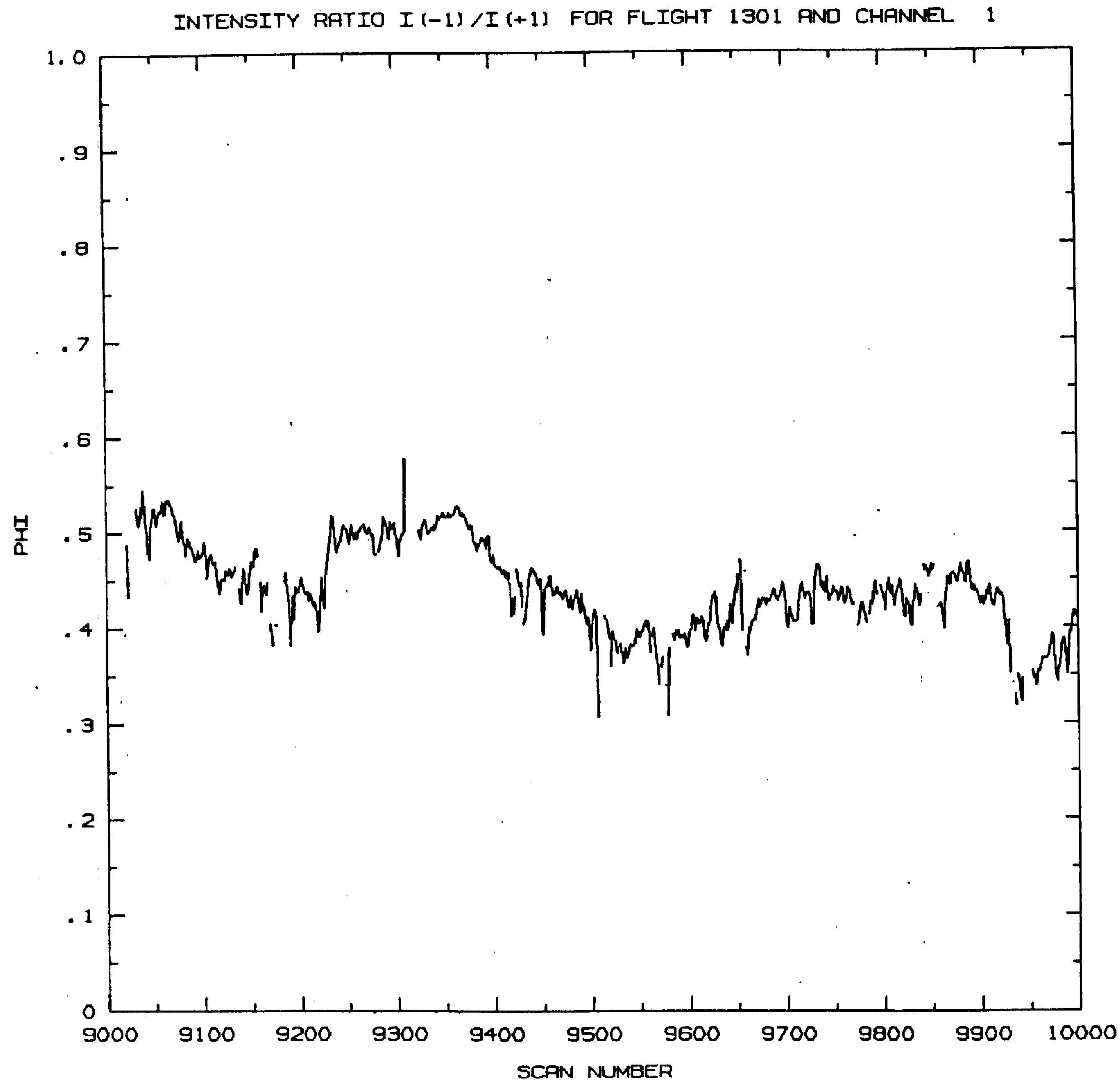
Channel 3
Wavelength: 0.7435 μm
Asymmetry factor: 0.84317

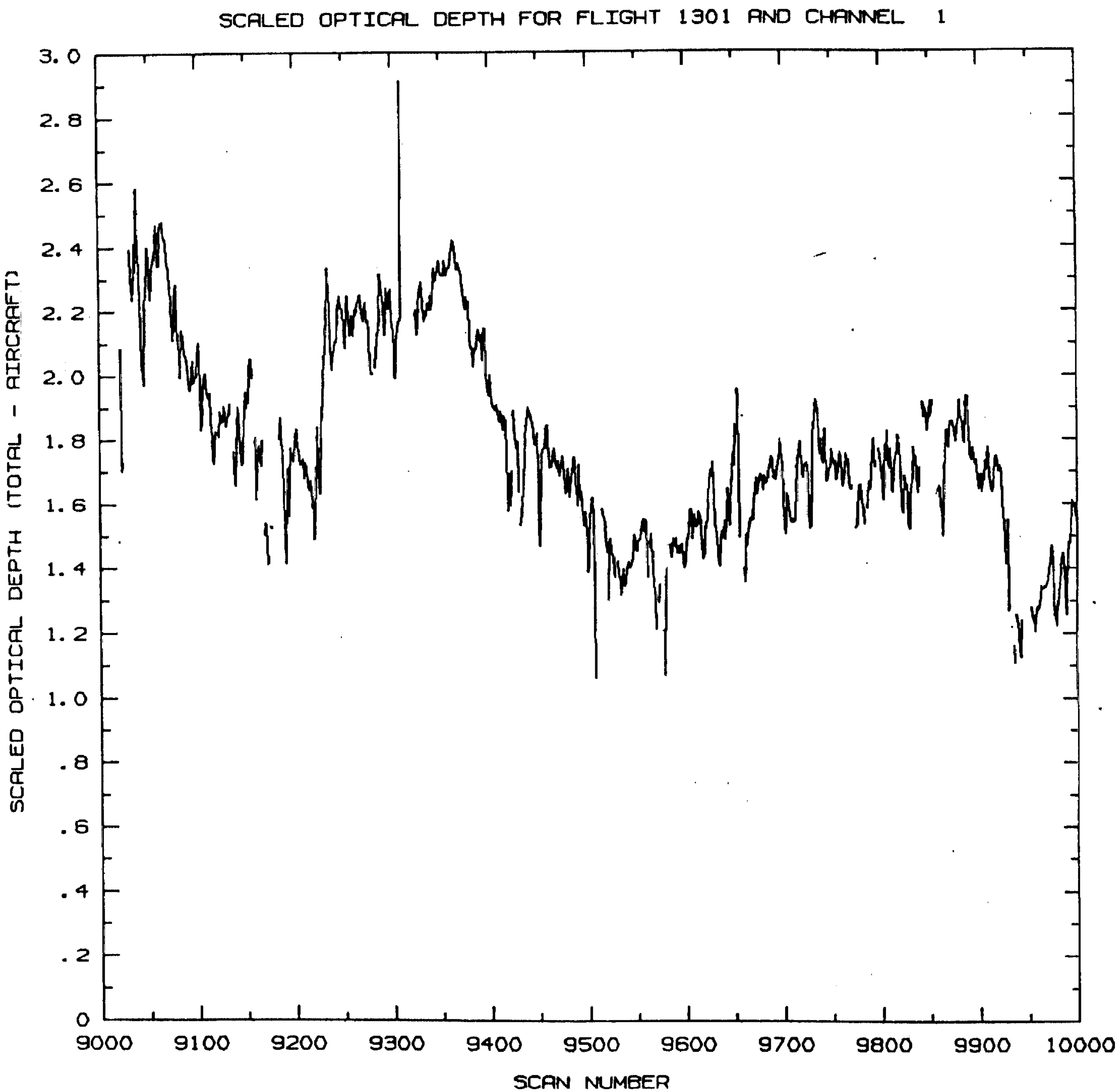
Flight Number: 1301
Ground albedo: 0.0634 +/- 0.0078

| Scan | Distance | Time | Intensity (-1) | Intensity (1) | Intensity ratio | Scaled Optical depth | Optical depth | s(0.7435) |
|---|---|---|---|---|---|---|---|---|
| 9127 | 51.19 | 9:32:19 | 7.0452 | 14.8114 | 0.4757 | 2.0760 | 13.24 | 0.0541 |
| 9128 | 51.24 | 9:32:20 | 7.0031 | 14.8846 | 0.4705 | 2.0578 | 13.12 | 0.0631 |
| 9129 | 51.29 | 9:32:20 | 7.0035 | 15.0802 | 0.4644 | 2.0077 | 12.80 | 0.0619 |
| 9130 | 51.34 | 9:32:21 | 7.1218 | 15.2382 | 0.4674 | 2.0112 | 12.82 | 0.0538 |
| 9131 | 51.39 | 9:32:21 | 7.1596 | 15.2385 | 0.4698 | 2.0459 | 13.05 | 0.0605 |
| 9132 | 51.44 | 9:32:22 | 7.1556 | 15.2326 | 0.4698 | 2.0448 | 13.04 | 0.0602 |
| 9133 | 51.48 | 9:32:23 | 7.2776 | 15.2379 | 0.4776 | 2.0837 | 13.29 | 0.0509 |
| 9137 | 51.68 | 9:32:25 | 7.1610 | 15.8633 | 0.4514 | 1.9226 | 12.26 | 0.0670 |
| 9138 | 51.73 | 9:32:26 | 6.8480 | 15.5111 | 0.4415 | 1.8171 | 11.59 | 0.0489 |
| 9139 | 51.78 | 9:32:26 | 6.8878 | 15.7857 | 0.4363 | 1.8085 | 11.53 | 0.0638 |
| 9140 | 51.83 | 9:32:27 | 7.2733 | 15.8970 | 0.4575 | 1.9388 | 12.36 | 0.0541 |
| 9141 | 51.88 | 9:32:28 | 7.5106 | 15.7449 | 0.4770 | 2.0739 | 13.22 | 0.0485 |
| 9142 | 51.93 | 9:32:28 | 7.3933 | 15.8222 | 0.4673 | 2.0387 | 13.00 | 0.0654 |
| 9143 | 51.98 | 9:32:29 | 7.4334 | 16.0566 | 0.4629 | 1.9927 | 12.71 | 0.0603 |
| 9144 | 52.03 | 9:32:29 | 7.3130 | 16.2094 | 0.4512 | 1.9286 | 12.30 | 0.0703 |
| 9145 | 52.07 | 9:32:30 | 7.3169 | 16.5633 | 0.4418 | 1.8752 | 11.96 | 0.0765 |
| 9146 | 52.12 | 9:32:31 | 7.3533 | 16.4846 | 0.4461 | 1.8869 | 12.03 | 0.0684 |
| 9147 | 52.17 | 9:32:31 | 7.3156 | 15.9788 | 0.4578 | 1.9402 | 12.37 | 0.0537 |
| 9148 | 52.22 | 9:32:32 | 7.3501 | 15.5057 | 0.4740 | 2.0666 | 13.18 | 0.0556 |
| 9149 | 52.27 | 9:32:33 | 7.3975 | 15.4356 | 0.4793 | 2.1249 | 13.55 | 0.0619 |
| 9150 | 52.32 | 9:32:33 | 7.3560 | 15.5135 | 0.4742 | 2.0687 | 13.19 | 0.0560 |
| 9151 | 52.37 | 9:32:34 | 7.3568 | 15.2789 | 0.4815 | 2.1213 | 13.53 | 0.0537 |
| 9152 | 52.42 | 9:32:34 | 7.3144 | 15.3525 | 0.4764 | 2.0854 | 13.30 | 0.0555 |
| 9153 | 52.47 | 9:32:35 | 7.4720 | 15.1975 | 0.4917 | 2.1978 | 14.01 | 0.0511 |
| 9154 | 52.52 | 9:32:36 | 7.4330 | 15.0432 | 0.4941 | 2.2350 | 14.25 | 0.0571 |

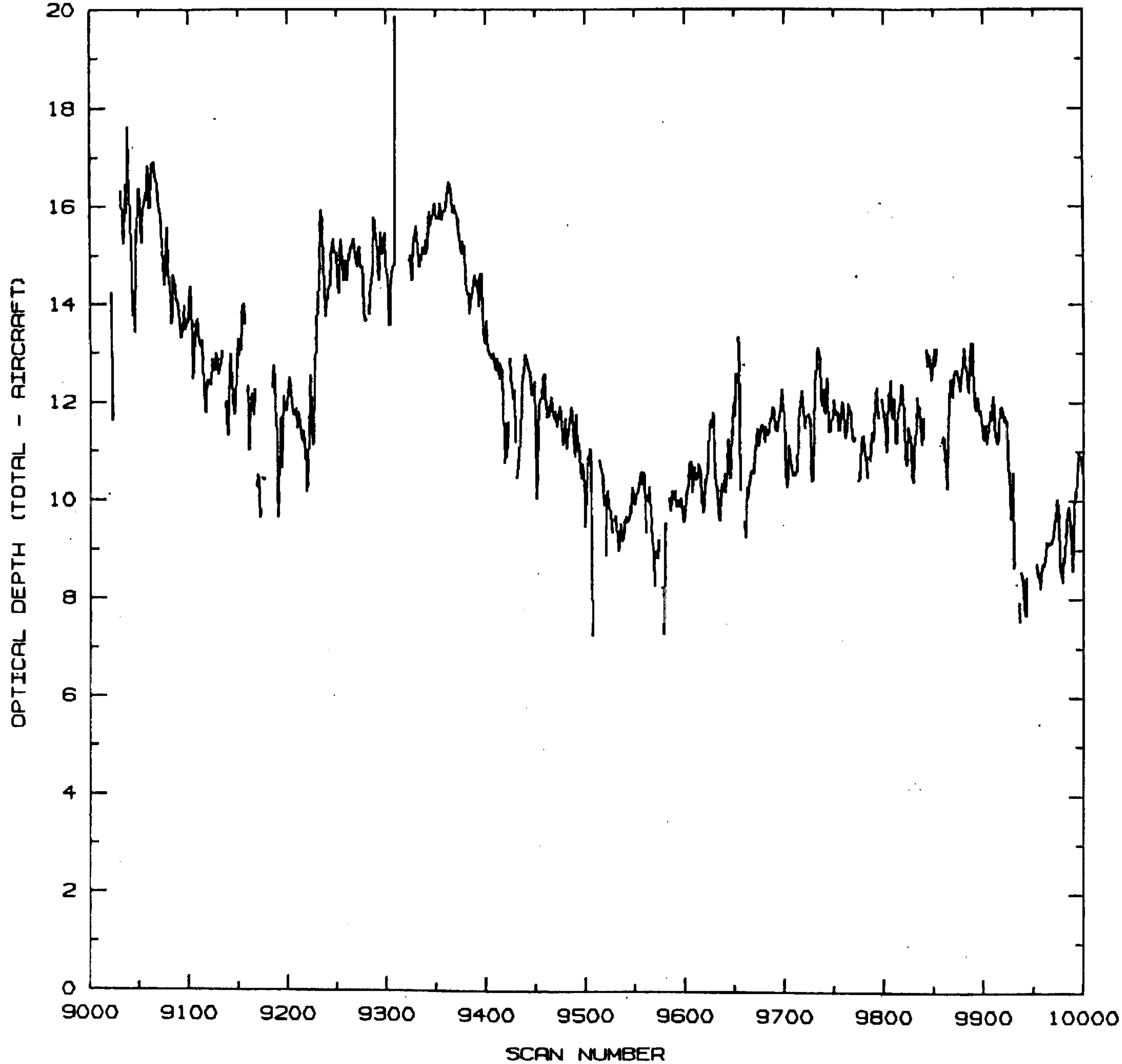
ZENITH AND NADIR INTENSITIES FOR FLIGHT 1301 AND CHANNEL 1



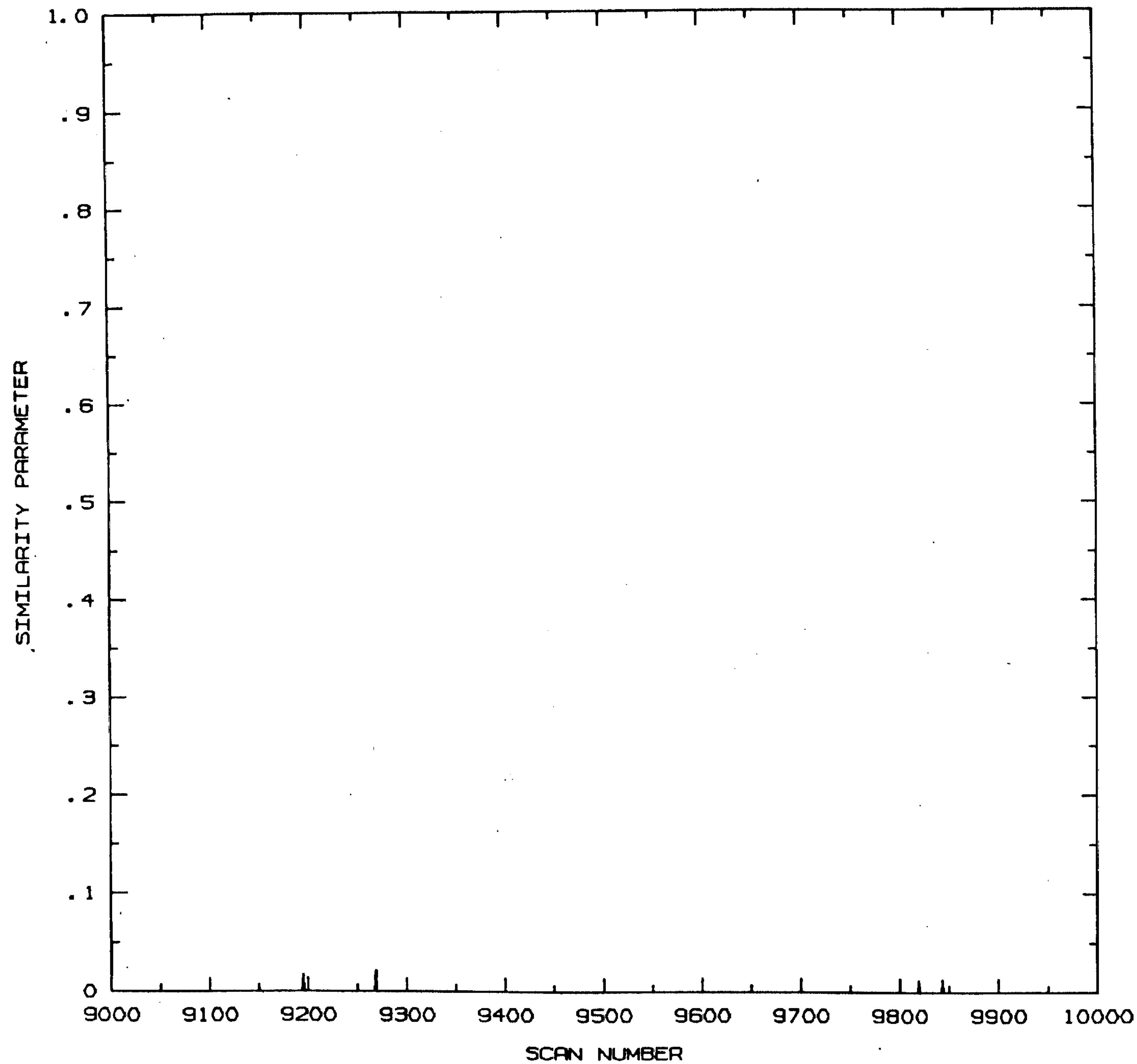

INTENSITY RATIO I(-1)/I(+1) FOR FLIGHT 1301 AND CHANNEL 1
PHI
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
9000
9100
9200
9300
9400
9500
9600
9700
9800
9900
10000
SCAN NUMBER


SCALED OPTICAL DEPTH FOR FLIGHT 1301 AND CHANNEL 1
SCALED OPTICAL DEPTH (TOTAL - AIRCRAFT)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
9000
9100
9200
9300
9400
9500
9600
9700
9800
9900
10000
SCAN NUMBER

OPTICAL DEPTH FOR FLIGHT 1301 AND CHANNEL 1



SIMILARITY PARAMETER FOR FLIGHT 1301 AND CHANNEL 1



```
C      PROGRAM CARANLYS - 07/05/88
C
C      PURPOSE
C        ANALYZE CLOUD ABSORPTION RADIOMETER DATA
C
C      DESCRIPTION OF PARAMETERS
C        MODE    - MODE OF DATA PROCESSING
C                  0 PERFORM QUALITY CONTROL TESTS FOR ALL SCAN LINES
C                  1 CREATE PLOTS FOR ALL SCAN LINES AND SELECTED CHANNELS
C                  2 DERIVE SPECTRAL GROUND ALBEDO AND PLOT RESULTS
C                  3 DERIVE SPECTRAL SIMILARITY PARAMETER USING INDIVIDUAL
C                    SCAN LINES AND PLOT RESULTS
C        WVL     - ARRAY OF WAVELENGTHS IN MICRONS
C        CALSLP  - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2-MICRON-SR-V)
C        CALINT  - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2-MICRON-SR)
C        AGO     - ARRAY OF GROUND ALBEDOS (WAVELENGTH)
C        SIGAG   - ARRAY OF GROUND ALBEDO STANDARD DEVIATIONS (WAVELENGTH)
C        IPRINT  - DUMMY VARIABLE FOR INPUT COMPATABILITY WITH PHIPLOT
C        ISCAN1  - ARRAY OF FIRST SCAN LINES TO BE PROCESSED
C        ISCAN2  - ARRAY OF LAST SCAN LINES TO BE PROCESSED
C
C      SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C        READ5
C           READ AND LIST DATA CARDS AND REWIND INPUT LOGICAL UNIT 5
C        CARDAT (MODE, NUMSCN, IPASS, ICH, IELEC, CALSLP, CALINT,
C                ISCAN1, ISCAN2, NFLT, NPASS, NSCAN, KSCAN, ITIME, ROLL,
C                INTFLX, KOUNTS, PHI, NCH8)
C           READ AIRCRAFT DATA FOR SCAN LINES BETWEEN ISCAN1 AND ISCAN2
C        STDEV (X, NX, XBAR, SIGX)
C           CALCULATE MEAN AND STANDARD DEVIATION OF X ARRAY
C        FINDS (TSTAR, PHIBAR, AG, SVAL)
C           INTERPOLATE S AND PHI ARRAYS USING SPLINE UNDER TENSION
C        SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY, IDXY, LTYP, LROW,
C                LBAC, NPAT, SYMBOL, XMIN, XMAX, YMIN, YMAX)
C           MAKE AN X-Y PLOT MIXING CURVES AND SYMBOLS, OR JUST SYMBOLS
C           ALONE, OR JUST CURVES ALONE, USING NCAR AUTOGRAPH ROUTINES
C
C      DESCRIPTION OF INPUT DATA DECK
C        MODE
C        WVL(1)            . . .         WVL(13)
C        CALSLP(1)         . . .         CALSLP(13)
C        CALINT(1)         . . .         CALINT(13)
C        AGO(1)            . . .         AGO(13)
C        SIGAG(1)          . . .         SIGAG(13)
C        IPRINT
C        ISCAN1(1)       ISCAN2(1)
C            .               .
C            .               .
C            .               .
C        ISCAN1(NPASS)   ISCAN2(NPASS)
C
C      COMMENTS
C        DIMENSION STATEMENTS VALID FOR NSCN  UP TO NUMSCN
C        DIMENSION STATEMENTS VALID FOR NPASS UP TO IPASS
C        DIMENSION STATEMENTS VALID FOR NCHAN UP TO ICH
C        VARIABLE INTFLX CONTAINS UP AND DOWN FLUXES FOR MODE = 2, AND
C           INTENSITIES AT 0 AND 180 DEGREES FOR ALL OTHER MODE'S
```

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C
C     MODIFICATIONS
C       8/18/86 - TO 7/31/85 VERSION, ADD MANUAL GAIN ADJUSTMENT AND
C                 TIED DOWN COSINE COMPARISON FOR DATA VALIDATION
C       7/02/87 - TO 8/18/86 VERSION, IMPLEMENT QUALITY CONTROL TESTS
C                 IN SUBROUTINE VALID8
C       3/23/88 - TO 7/02/87 VERSION, ADD UP/DOWN ARRAYS AND STATISTICS
C                 AND NCAR PLOTTING (SEZMXY FROM WJW)
C       4/04/88 - TO 3/23/88 VERSION, ADD NEW MODE TO GET QUICK LOOK
C                 PLOTS FOR ALL SCAN LINES (NEW MODE = 1) AND MAKE
C                 PROGRAM MOSTLY SINGLE PRECISION
C       5/09/88 - TO 4/04/88 VERSION, ADD MODE TO PROCESS INDIVIDUAL
C                 SCAN LINES AND PLOT RESULTS (NEW MODE = 3)
C       6/22/88 - TO 5/09/88 VERSION, ADD SUBROUTINE INTGR8 TO INTEGRATE
C                 THE INTENSITIES FOR EACH SCAN TO GET UPWARD AND DOWN-
C                 WARD FLUXES FOR MODE 2 (GROUND ALBEDO CALCULATIONS)
C       7/05/88 - TO 6/22/88 VERSION, ADD WAVELENGTH DEPENDENCE OF
C                 OPTICAL THICKNESS TO MODE 3 (DATA ANALYSIS)
C
C     REFERENCES
C       KING, M. D., 1981:  J. ATMOS. SCI., 38, 2031-2044.
C       KING, M. D., M. G. STRANGE, P. LEONE, AND L. R. BLAINE, 1986:
C         J. ATMOS. OCEAN. TECH., 3, 513-522
C
      PARAMETER (NUMSCN = 16000, IDXY = 1000)
      PARAMETER (IPASS = 50, ICH = 13, IELEC = 8, MAXCRV = 3)
      CHARACTER*1  SYMBOL(MAXCRV)
      CHARACTER*60 LABG,LABX,LABY
      DOUBLE PRECISION X(IDXY,MAXCRV),Y(IDXY,MAXCRV)
      DOUBLE PRECISION XMIN,XMAX,YMIN,YMAX
      REAL*4           INTFLX(NUMSCN,IELEC,2)
      DIMENSION KOUNTS(NUMSCN,IELEC,2)
      DIMENSION PHI(NUMSCN,IELEC),T(NUMSCN,ICH),S(NUMSCN,ICH)
      DIMENSION PHIB(ICH,IPASS),SIGP(ICH,IPASS),LSCN1(ICH,IPASS)
      DIMENSION SMEAN(ICH,IPASS),SIGS(ICH,IPASS)
      DIMENSION KSCAN(NUMSCN),ITIME(NUMSCN),ROLL(NUMSCN),NCH8(NUMSCN)
      DIMENSION RATIO(NUMSCN),UP(NUMSCN),DN(NUMSCN),TVALUE(NUMSCN)
      DIMENSION SVALUE(NUMSCN),ISCAN1(IPASS),ISCAN2(IPASS),NSCAN(IPASS)
      DIMENSION TMEAN(ICH,IPASS),SIGT(ICH,IPASS),TAU(ICH,IPASS)
      DIMENSION SIGTAU(ICH,IPASS),NPTS(MAXCRV),RECG(ICH),LSCN(ICH)
      DIMENSION WVL(ICH),CALSLP(ICH),CALINT(ICH),AGO(ICH),SIGAG(ICH)
      DIMENSION G(ICH),TSPEC(ICH),TPSPEC(ICH),PHIAVG(ICH),SIGAVG(ICH)
      DATA      QP/0.714/,ISCEND/0/,LSCN1/650*0/
      DATA      G/0.85334,0.84675,0.84317,0.83881,0.83280,0.82677,
     1            0.82452,0.81344,0.80855,0.80543,0.80339,0.79775,
     2            0.80170/
      DATA      TSPEC/14.282,14.475,14.553,14.678,14.843,15.007,
     1                15.055,15.323,15.402,15.465,15.683,15.920,
     2                16.085/
      NCHAN = ICH
      CALL READ5
      CALL NCVIEW (-0.77)
C
C       INITIALIZE SPECTRAL SCALED OPTICAL THICKNESS ARRAY
C
      DO 5 NC = 1,NCHAN
        RECG(NC)   = 1.0 / (1.0 - G(NC))
        TPSPEC(NC) = (1.0 - G(NC)) * TSPEC(NC)
```

```
    5     CONTINUE
C
C        READ INPUT DATA
C
      READ (5,1000) MODE
      READ (5,1010) (WVL(NC),NC=1,ICH)
      READ (5,1010) (CALSLP(NC),NC=1,ICH)
      READ (5,1010) (CALINT(NC),NC=1,ICH)
      READ (5,1010) (AGO(NC),NC=1,ICH)
      READ (5,1010) (SIGAG(NC),NC=1,ICH)
      READ (5,1000) IPRINT
      CALL CARDAT (MODE, NUMSCN, IPASS, ICH, IELEC, CALSLP, CALINT,
     1             ISCAN1, ISCAN2, NFLT, NPASS, NSCAN, KSCAN, ITIME,
     2             ROLL, INTFLX, KOUNTS, PHI, NCH8)
C
C        IF MODE = 0, PROCESS CHANNEL 1 DATA TO GET OUTPUT TABLE SHOWING
C        THE TIMES AT WHICH THE CLOUD ABSORPTION RADIOMETER OBSERVATIONS
C        ARE IN THE DIFFUSION DOMAIN
C
      IF (MODE .EQ. 0) NCHAN = 1
C
C        BEGIN ANALYSIS OF AIRCRAFT DATA FOR EACH GROUP OF SCAN LINES
C
      DO 140 NP = 1,NPASS
         NSCN   = NSCAN(NP)
         ISCSTR = ISCEND + 1
         ISCEND = ISCEND + NSCN
         IF (NSCN .LT. 2) GO TO 140
         DO 20 I = 1,IDXY
            X(I,1) = ISCAN1(NP) + I - 1
            DO 10 J = 1,MAXCRV
               Y(I,J) = 1.0D+36
   10          CONTINUE
   20       CONTINUE
C
C           BEGIN ANALYSIS OF AIRCRAFT DATA FOR EACH CHANNEL
C
         DO 120 NC = 1,NCHAN
            NC8 = NC
            IF (NC .GE. IELEC) NC8 = IELEC
            IF (MODE .EQ. 1) GO TO 60
C
C              BEGIN ANALYSIS OF AIRCRAFT DATA FOR EACH SCAN LINE
C
            LSCAN    = 0
            LSCN(NC) = 0
            DO 50 N = ISCSTR,ISCEND
               IF (N .EQ. ISCSTR) THEN
                  IF (MODE .EQ. 2) THEN
                     WRITE (6,1020) NC,NFLT,WVL(NC),AGO(NC),SIGAG(NC),
     1                              CALSLP(NC),CALINT(NC)
                     ELSE
                        WRITE (6,1030) NC,NFLT,WVL(NC),AGO(NC),
     1                                 SIGAG(NC),CALSLP(NC),CALINT(NC)
                        END IF
                  IF (NC .EQ. 1) THEN
                     IF (AGO(1) .EQ. 1.0) AGO(1) = 0.0
                     DEN1 = 1.0 - AGO(1)
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              IF (AGO(2) .EQ. 1.0) AGO(2) = 0.0
              DEN2 = 1.0 - AGO(2)
              END IF
           END IF
        IF ((NC .GE. IELEC) .AND. (NCH8(N) .NE. NC)) GO TO 50
        IF ((PHI(N,NC8) .LE. 0.0) .AND. (MODE .GT. 2)) GO TO 50
        IF (LSCAN .GT. 1) THEN
           IF (MOD(LSCAN,49) .EQ. 0) THEN
              IF (MODE .EQ. 2) THEN
                 WRITE (6,1020) NC,NFLT,WVL(NC),AGO(NC),
     1                          SIGAG(NC),CALSLP(NC),CALINT(NC)
                 ELSE
                    WRITE(6,1030) NC,NFLT,WVL(NC),AGO(NC),
     1                            SIGAG(NC),CALSLP(NC),CALINT(NC)
                    END IF
              END IF
           END IF
        LSCAN        = LSCAN + 1
        LSCN(NC)     = LSCAN
        LSCN1(NC,NP) = LSCN1(NC,NP) + 1
        IHR          = ITIME(N)/10000
        IMN1         = ITIME(N) - 10000*IHR
        IMN          = IMN1/100
        ISEC         = IMN1 - 100*IMN
        IF ((MODE .EQ. 0) .OR. (MODE .EQ. 2)) GO TO 40
C
C         COMPUTE SCALED OPTICAL DEPTH FOR INDIVIDUAL SCAN LINE
C         ASSUMING CONSERVATIVE SCATTERING IN CHANNELS 1 OR 2
C
        IF (NC .GE. 2) GO TO 30
        TCH1 = (1.0 + PHI(N,1)) / (1.0 - PHI(N,1)) -
     1         4.0 * AGO(1) / (3.0 * DEN1) - QP
        TCH2 = (1.0 + PHI(N,2)) / (1.0 - PHI(N,2)) -
     1         4.0 * AGO(2) / (3.0 * DEN2) - QP
        IF (TCH1 .GE. TCH2 * TPSPEC(1)/TPSPEC(2)) THEN
           T(N,1) = TCH1
           S(N,1) = 0.0
           GO TO 40
           ELSE
              T(N,2) = TCH2
              T(N,1) = T(N,2) * TPSPEC(1)/TPSPEC(2)
              S(N,2) = 0.0
              END IF
C
C         COMPUTE SIMILARITY PARAMETER FOR NONCONSERVATIVE
C         CHANNELS
C
   30   IF ((NC .EQ. 2) .AND. (S(N,1) .NE. 0.0)) GO TO 40
        AG = AGO(NC)
        IF (AG .EQ. 1.0) AG = 0.0
        T(N,NC) = T(N,1) * TPSPEC(NC)/TPSPEC(1)
        CALL FINDS (T(N,NC), PHI(N,NC8), AG, S(N,NC))
C
C         PRINT OUT TABLE OF PROCESSED DATA FOR EACH SCAN LINE
C
   40   IF (MODE .EQ. 2) THEN
           WRITE (6,1040) KSCAN(N),ROLL(N),IHR,IMN,ISEC,
     1                    KOUNTS(N,NC8,2),KOUNTS(N,NC8,1),
```

```
     2                        INTFLX(N,NC8,2),INTFLX(N,NC8,1),
     3                        PHI(N,NC8)
                 ELSE
                    IF (MODE .EQ. 0) THEN
                       WRITE (6,1040) KSCAN(N),ROLL(N),IHR,IMN,ISEC,
     1                                KOUNTS(N,NC8,2),KOUNTS(N,NC8,1),
     2                                INTFLX(N,NC8,2),INTFLX(N,NC8,1),
     3                                PHI(N,NC8)
                    ELSE
                       WRITE (6,1040) KSCAN(N),ROLL(N),IHR,IMN,ISEC,
     1                                KOUNTS(N,NC8,2),
     2                                KOUNTS(N,NC8,1),
     3                                INTFLX(N,NC8,2),
     4                                INTFLX(N,NC8,1),
     5                                PHI(N,NC8),T(N,NC),S(N,NC)
                    END IF
                 END IF
              RATIO(LSCAN)  = PHI(N,NC8)
              UP(LSCAN)     = INTFLX(N,NC8,2)
              DN(LSCAN)     = INTFLX(N,NC8,1)
              TVALUE(LSCAN) = T(N,NC)
              SVALUE(LSCAN) = S(N,NC)
   50         CONTINUE
C
C             END ANALYSIS OF AIRCRAFT DATA FOR EACH SCAN LINE
C
           IF (LSCAN .LE. 1) GO TO 120
           CALL STDEV (RATIO, LSCAN, PHIB(NC,NP), SIGP(NC,NP))
           CALL STDEV (UP, LSCAN, UPMEAN, SIGUP)
           CALL STDEV (DN, LSCAN, DNMEAN, SIGDN)
           IF (MODE .GT. 2) THEN
              CALL STDEV (TVALUE, LSCAN, TMEAN(NC,NP), SIGT(NC,NP))
              CALL STDEV (SVALUE, LSCAN, SMEAN(NC,NP), SIGS(NC,NP))
              TAU(NC,NP)    = RECG(NC) * TMEAN(NC,NP)
              SIGTAU(NC,NP) = RECG(NC) * SIGT(NC,NP)
              WRITE (6,1050) LSCAN,PHIB(NC,NP),SIGP(NC,NP),UPMEAN,
     1                    SIGUP,DNMEAN,SIGDN,TMEAN(NC,NP),
     2                    SIGT(NC,NP),TAU(NC,NP),SIGTAU(NC,NP),
     3                    SMEAN(NC,NP),SIGS(NC,NP)
           ELSE
              IF (MODE .EQ. 0) THEN
                 WRITE (6,1055) LSCAN,PHIB(NC,NP),SIGP(NC,NP),
     1                       UPMEAN,SIGUP,DNMEAN,SIGDN
              ELSE
                 WRITE (6,1060) LSCAN,PHIB(NC,NP),SIGP(NC,NP),
     1                       UPMEAN,SIGUP,DNMEAN,SIGDN
              END IF
           END IF
C
C             PLOT ZENITH AND NADIR PROPAGATING INTENSITIES OR FLUXES
C             AS A FUNCTION OF SCAN NUMBER FOR SELECTED CHANNELS
C
   60      IF ((MODE .EQ. 1) .AND.
     1         ((NC .EQ. 1) .OR. (NC .EQ. 2) .OR. (NC .EQ. 3) .OR.
     2          (NC .EQ. 9) .OR. (NC .EQ. 12)) .OR.
     3          (MODE .EQ. 2) .OR. (MODE .EQ. 3)) THEN
              LABX  = 'SCAN NUMBER$'
              LABY  = 'INTENSITY (MW/(CM**2-MICRON-SR))$'
```

```
            WRITE (LABG,1070) NFLT,NC
            IF (MODE .EQ. 2) THEN
               LABY  = 'FLUX (MW/(CM**2-MICRON))$'
               WRITE (LABG,1080) NFLT,NC
               END IF
            MANY  = 2
            LTYP  = 1
            LROW  = 1
            LBAC  = 1
            NPAT  = 1
            DO 70 N = ISCSTR,ISCEND
               LSCAN = KSCAN(N) - ISCAN1(NP) + 1
               IF ((NC .GT. 7) .AND. (NCH8(N) .NE. NC)) THEN
                  Y(LSCAN,1) = 1.0D+36
                  Y(LSCAN,2) = 1.0D+36
                  Y(LSCAN,3) = 1.0D+36
                  ELSE
                     Y(LSCAN,1) = INTFLX(N,NC8,1)
                     Y(LSCAN,2) = INTFLX(N,NC8,2)
                     Y(LSCAN,3) = PHI(N,NC8)
                     END IF
 70            CONTINUE
            XMIN      = ISCAN1(NP)
            XMAX      = ISCAN2(NP)
            YMIN      = 1.0D-4
            YMAX      = 0.0D0
            NPTS(1)   = ISCAN2(NP) - ISCAN1(NP) + 1
            NPTS(2)   = NPTS(1)
            SYMBOL(1) = 'L'
            SYMBOL(2) = 'L'
            CALL SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY, IDXY,
     1                   LTYP, LROW, LBAC, NPAT, SYMBOL, XMIN, XMAX,
     2                   YMIN, YMAX)
C
C             PLOT INTENSITY RATIO OR GROUND ALBEDO AS A FUNCTION OF
C             SCAN NUMBER FOR A SINGLE CHANNEL
C
            WRITE (LABG,1090) NFLT,NC
            LABY   = 'PHI$'
            IF (MODE .EQ. 2) THEN
               WRITE (LABG,1100) NFLT,NC
               LABY   = 'GROUND ALBEDO$'
               END IF
            MANY   = 1
            NPHIGD = 0
            DO 80 N = ISCSTR,ISCEND
               LSCAN = KSCAN(N) - ISCAN1(NP) + 1
               IF ((Y(LSCAN,3) .LE. 0.0D0) .OR.
     1             (Y(LSCAN,3) .GE. 1.0D0)) THEN
                  Y(LSCAN,1) = 1.0D+36
                  ELSE
                     NPHIGD = NPHIGD + 1
                     Y(LSCAN,1) = Y(LSCAN,3)
                     END IF
 80            CONTINUE
            YMIN    = 1.0D-4
            YMAX    = 1.0D0
            IF (NPHIGD .GT. 0)
```

```
     1            CALL SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY,
     2                         IDXY, LTYP, LROW, LBAC, NPAT, SYMBOL,
     3                         XMIN, XMAX, YMIN, YMAX)
C
C                PLOT SCALED OPTICAL DEPTH AND OPTICAL DEPTH AS A
C                FUNCTION OF SCAN NUMBER
C
               IF (MODE .NE. 3) GO TO 120
               IF (NC .EQ. 1) THEN
                  WRITE (LABG,1110) NFLT,NC
                  LABY  = 'SCALED OPTICAL DEPTH (TOTAL - AIRCRAFT)$'
                  DO 90 N = ISCSTR,ISCEND
                     LSCAN = KSCAN(N) - ISCAN1(NP) + 1
                     Y(LSCAN,1) = T(N,1)
   90                CONTINUE
                  YMIN = 1.0D-4
                  YMAX = 0.0D0
                  CALL SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY, IDXY,
     1                         LTYP, LROW, LBAC, NPAT, SYMBOL, XMIN,
     2                         XMAX, YMIN, YMAX)
                  WRITE (LABG,1120) NFLT,NC
                  LABY  = 'OPTICAL DEPTH (TOTAL - AIRCRAFT)$'
                  DO 100 N = ISCSTR,ISCEND
                     LSCAN = KSCAN(N) - ISCAN1(NP) + 1
                     Y(LSCAN,1) = RECG(1) * T(N,1)
  100                CONTINUE
                  YMIN = 1.0D-4
                  YMAX = 0.0D0
                  CALL SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY, IDXY,
     1                         LTYP, LROW, LBAC, NPAT, SYMBOL, XMIN,
     2                         XMAX, YMIN, YMAX)
                  END IF
C
C                 PLOT SIMILARITY PARAMETER AS A FUNCTION OF SCAN NUMBER
C                 FOR A SINGLE CHANNEL
C
               WRITE (LABG,1130) NFLT,NC
               LABY  = 'SIMILARITY PARAMETER$'
               DO 110 N = ISCSTR,ISCEND
                  LSCAN = KSCAN(N) - ISCAN1(NP) + 1
                  IF ((Y(LSCAN,3) .LE. 0.0D0) .OR.
     1                (Y(LSCAN,3) .GE. 1.0D0)) THEN
                     Y(LSCAN,1) = 1.0D+36
                     ELSE
                        Y(LSCAN,1) = S(N,NC)
                        END IF
  110             CONTINUE
               YMIN = 1.0D-4
               YMAX = 1.0D0
               CALL SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY,
     1                      IDXY, LTYP, LROW, LBAC, NPAT, SYMBOL,
     2                      XMIN, XMAX, YMIN, YMAX)
               END IF
  120       CONTINUE
C
C           END ANALYSIS OF AIRCRAFT DATA FOR EACH PASS, ALL CHANNELS
C
         IF (MODE .NE. 1) THEN
```

```
         IF (MODE .EQ. 2) THEN
            WRITE (20,1000) ISCAN1(NP),ISCAN2(NP)
            WRITE (20,1010) (PHIB(NC,NP),NC=1,ICH)
            WRITE (20,1010) (SIGP(NC,NP),NC=1,ICH)
            WRITE (6,1140)  NFLT,ISCAN1(NP),ISCAN2(NP)
            ELSE
               WRITE (6,1150) NFLT,ISCAN1(NP),ISCAN2(NP)
               END IF
         DO 130 NC = 1,NCHAN
            IF (MODE .EQ. 2) THEN
               WRITE (6,1160) NC,WVL(NC),LSCN1(NC,NP),PHIB(NC,NP),
     1                        SIGP(NC,NP)
               ELSE
                  IF (MODE .EQ. 0) THEN
                     WRITE (6,1160) NC,WVL(NC),LSCN(NC),PHIB(NC,NP),
     1                              SIGP(NC,NP),AGO(NC),SIGAG(NC)
                     ELSE
                        WRITE (6,1160) NC,
     1                                 WVL(NC),LSCN(NC),PHIB(NC,NP),
     2                                 SIGP(NC,NP),AGO(NC),SIGAG(NC),
     3                                 SMEAN(NC,NP),SIGS(NC,NP),
     4                                 TAU(NC,NP),SIGTAU(NC,NP)
                        END IF
                  END IF
  130       CONTINUE
         END IF
  140 CONTINUE
C
C       END ANALYSIS OF AIRCRAFT DATA FOR ALL GROUPS OF SCAN LINES
C
      IF (MODE .EQ. 1) GO TO 170
C
C       FOR (MODE .EQ. 2) AND (NPASS .GT. 1), CALCULATE AND PRINT OUT
C       SUMMARY TABLE OF AGO'S AND ERROR'S AVERAGED FOR ALL SCAN LINE
C       RANGES
C
      IF ((MODE .EQ. 2) .AND. (NPASS .GT. 1)) THEN
        WRITE (6,1140) NFLT,ISCAN1(1),ISCAN2(NPASS)
        DO 160 NC = 1,ICH
           LSC   = 0
           SUMX  = 0.0
           SUMX2 = 0.0
           DO 150 NP = 1,NPASS
              LSCAN = LSCN1(NC,NP)
              LSC   = LSC   + LSCAN
              SUMX  = SUMX  + LSCAN*PHIB(NC,NP)
              SUMX2 = SUMX2 + (LSCAN - 1.0)*SIGP(NC,NP)*SIGP(NC,NP)
     1                      + LSCAN*PHIB(NC,NP)*PHIB(NC,NP)
  150         CONTINUE
           PHIAVG(NC) = SUMX  / LSC
           SIGAVG(NC) = SUMX2 - LSC*PHIAVG(NC)*PHIAVG(NC)
           IF (SIGAVG(NC) .LT. 0.0) SIGAVG(NC) = 0.0
           SIGAVG(NC) = SQRT(SIGAVG(NC) / (LSC - 1.0))
           WRITE (6,1160) NC,WVL(NC),LSC,PHIAVG(NC),SIGAVG(NC)
  160      CONTINUE
        WRITE (20,1000) ISCAN1(1),ISCAN2(NPASS)
        WRITE (20,1010) (PHIAVG(NC),NC=1,ICH)
        WRITE (20,1010) (SIGAVG(NC),NC=1,ICH)
```

```
         REWIND 25
         END IF
 170 WRITE (6,1170) MODE
     STOP
1000 FORMAT(7I10)
1010 FORMAT(7F10.4)
1020 FORMAT(1H1,/,9H CHANNEL:,I3,45X,14HFLIGHT NUMBER:,I5,/,
    1        12H WAVELENGTH:,F7.4,8H MICRONS,30X,14HGROUND ALBEDO:,F7.4,
    2        4H +/-,F7.4,/,20H CALIBRATION SLOPE =,F7.4,
    3        23H MW/(CM**2-MICRON-SR-V),7X,23HCALIBRATION INTERCEPT =,
    4        F7.3,21H MW/(CM**2-MICRON-SR),//,21X,4HTIME,3X,
    5        2(3X,5HCOUNT),6X,8HFLUX(-1),6X,7HFLUX(1),/,6H  SCAN,4X,
    6        4HROLL,4X,10HHR MIN SEC,4X,4H(-1),4X,3H(1),7X,8HMW / (CM,
    7        13H**2 - MICRON),6X,6HALBEDO,/,1X,5(1H-),3X,
    8        6(1H-),3X,10(1H-),2(3X,5(1H-)),6X,21(1H-),6X,6(1H-))
1030 FORMAT(1H1,/,9H CHANNEL:,I3,45X,14HFLIGHT NUMBER:,I5,/,
    1        12H WAVELENGTH:,F7.4,8H MICRONS,30X,14HGROUND ALBEDO:,F7.4,
    2        4H +/-,F7.4,/,20H CALIBRATION SLOPE =,F7.4,
    3        23H MW/(CM**2-MICRON-SR-V),7X,23HCALIBRATION INTERCEPT =,
    4        F7.3,21H MW/(CM**2-MICRON-SR),//,21X,4HTIME,3X,
    5        2(3X,5HCOUNT),3X,27HINTENSITY(-1)  INTENSITY(1),16X,
    6        6HSCALED,5X,10HSIMILARITY,/,6H  SCAN,4X,4HROLL,4X,
    7        10HHR MIN SEC,4X,4H(-1),4X,3H(1),4X,11HMW / (CM**2,
    8        16H - MICRONS - SR),5X,3HPHI,4X,13HOPTICAL DEPTH,
    9        2X,9HPARAMETER,/,1X,5(1H-),3X,6(1H-),3X,10(1H-),
    A        2(3X,5(1H-)),3X,27(1H-),3X,6(1H-),3X,13(1H-),2X,10(1H-))
1040 FORMAT(I6,F8.2,I6,2I4,I7,I8,2F14.4,F12.4,2F13.4)
1050 FORMAT(18HONUMBER OF SCANS =,I6,/,
    1        11H I(-1)/I(1),5X,2H =,F8.4,4H +/-,F7.4,/,
    2         6H I(-1),10X,2H =,F8.4,4H +/-,F7.4,
    3        21H MW/(CM**2-MICRON-SR),/,
    4         5H I(1),11X,2H =,F8.4,4H +/-,F7.4,
    5        21H MW/(CM**2-MICRON-SR),/,
    6        11H SCALED TAU,5X,2H =,F8.4,4H +/-,F7.4,/,
    7         4H TAU,12X,2H =,F8.4,4H +/-,F7.4,/,
    8         2H S,14X,2H =,F8.4,4H +/-,F7.4)
1055 FORMAT(18HONUMBER OF SCANS =,I6,/,
    1        11H I(-1)/I(1),5X,2H =,F8.4,4H +/-,F7.4,/,
    2         6H I(-1),10X,2H =,F8.4,4H +/-,F7.4,
    3        21H MW/(CM**2-MICRON-SR),/,
    4         5H I(1),11X,2H =,F8.4,4H +/-,F7.4,
    5        21H MW/(CM**2-MICRON-SR))
1060 FORMAT(18HONUMBER OF SCANS =,I6,/,
    1         7H ALBEDO,10X,1H=,F8.4,4H +/-,F7.4,/,
    2         9H FLUX(UP),8X,1H=,F8.4,4H +/-,F7.4,
    3        18H MW/(CM**2-MICRON),/,
    4        11H FLUX(DOWN),6X,1H=,F8.4,4H +/-,F7.4,
    5        18H MW/(CM**2-MICRON))
1070 FORMAT('ZENITH AND NADIR INTENSITIES FOR FLIGHT',I5,
    1        ' AND CHANNEL',I3,'$')
1080 FORMAT('UPWARD AND DOWNWARD FLUXES FOR FLIGHT',I5,
    1        ' AND CHANNEL',I3,'$')
1090 FORMAT('INTENSITY RATIO I(-1)/I(+1) FOR FLIGHT',I5,
    1        ' AND CHANNEL',I3,'$')
1100 FORMAT('GROUND ALBEDO FOR FLIGHT',I5,' AND CHANNEL',I3,'$')
1110 FORMAT('SCALED OPTICAL DEPTH FOR FLIGHT',I5,
    1        ' AND CHANNEL',I3,'$')
1120 FORMAT('OPTICAL DEPTH FOR FLIGHT',I5,' AND CHANNEL',I3,'$')
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 1130 FORMAT('SIMILARITY PARAMETER FOR FLIGHT',I5,' AND CHANNEL',
     1        I3,'$')
 1140 FORMAT(1H1,/,15H FLIGHT NUMBER:,I5,/,21H SCAN NUMBER RANGE IS,
     1        I6,3H TO,I6,//,10X,10HWAVELENGTH,3X,6HNUMBER,/,1X,
     2        7HCHANNEL,4X,6HMICRON,4X,8HOF SCANS,7X,13HGROUND ALBEDO,/,
     3        1X,7(1H-),2X,10(1H-),2X,8(1H-),5X,17(1H-),/)
 1150 FORMAT(1H1,/,15H FLIGHT NUMBER:,I5,/,21H SCAN NUMBER RANGE IS,
     1        I6,3H TO,I6,//,10X,10HWAVELENGTH,3X,6HNUMBER,/,
     2        1X,7HCHANNEL,4X,6HMICRON,4X,8HOF SCANS,12X,3HPHI,
     3        16X,13HGROUND ALBEDO,7X,20HSIMILARITY PARAMETER,5X,
     4        17HOPTICAL THICKNESS,/,1X,7(1H-),2X,10(1H-),2X,8(1H-),5X,
     5        17(1H-),2X,2(5X,17(1H-)),3(1H-),5X,18(1H-),/)
 1160 FORMAT(I5,F13.4,I10,4(F13.4,4H +/-,F7.4))
 1170 FORMAT(1H1,//,36H THE QUALITY CONTROL CATEGORIES ARE:,//,
     1        5H DATA,/,17H QUAL  DEFINITION,/,1X,4(1H-),2X,10(1H-),/,
     2        3X,1H0,3X,15HACCEPTABLE DATA,/,
     3        3X,1H1,3X,40HNADIR INTENSITY EXCEEDS ZENITH INTENSITY,/,
     4        3X,1H2,3X,38HNUMBER OF TIMES DEVIATIONS FROM COSINE,
     5        29H CURVE CHANGE SIGN IS .LE. 3,,/,
     6        7X,32HFOR XMU BETWEEN 0.9 AND -0.9 AND,
     7        44H STANDARD DEVIATION .GT. 0.5*(STDDEV THRESH),/,
     8        3X,1H3,3X,39HSAMPLE STANDARD DEVIATION AROUND COSINE,
     9        35H CURVE EXCEEDS 5% OF MEAN AMPLITUDE,/,
     A        3X,1H4,3X,35HMAXIMUM DEVIATION FROM COSINE CURVE,
     B        30H EXCEEDS 10% OF MEAN AMPLITUDE,//,
     C        32H THE MODE OF DATA PROCESSING IS ,I1,7H WHERE:,//,
     D        55H   0 = PERFORM QUALITY CONTROL TESTS FOR ALL SCAN LINES,
     E        /,48H   1 = PLOT SELECTED CHANNELS FOR ALL SCAN LINES,/,
     F        53H   2 = DERIVE SPECTRAL GROUND ALBEDO AND PLOT RESULTS,/,
     G        49H   3 = DERIVE SPECTRAL SIMILARITY PARAMETER USING,
     H        39H INDIVIDUAL SCAN LINES AND PLOT RESULTS)
      END
C     SUBROUTINE READ5
C
C     PURPOSE
C       READS AND WRITES INPUT DATA CARDS FROM LOGICAL UNIT 5
C
C     USAGE
C       CALL READ5
C
C     DESCRIPTION OF PARAMETERS
C       NONE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
C
C     COMMENTS
C       SUBROUTINE REWINDS LOGICAL UNIT 5 SO THE INPUT IS READY TO BE
C       READ BY THE PROGRAM
C
      SUBROUTINE READ5
      DIMENSION CARD(18)
      WRITE (6,1000)
   10 READ (5,1010,END=999) CARD
      WRITE (6,1020) CARD
      GO TO 10
  999 CONTINUE
      REWIND 5
```

```
      RETURN
 1000 FORMAT(1H1,//,10X,'THE CONTENTS OF THE INPUT FILE ON UNIT 5 ARE:',
     1       //)
 1010 FORMAT(18A4)
 1020 FORMAT(10X,18A4)
      END
C     SUBROUTINE CARDAT
C
C     PURPOSE
C       READ AIRCRAFT DATA FOR SCAN LINES BETWEEN ISCAN1 AND ISCAN2
C
C     USAGE
C       CALL CARDAT (MODE, NUMSCN, IPASS, ICH, IELEC, CALSLP, CALINT,
C                    ISCAN1, ISCAN2, NFLT, NPASS, NSCAN, KSCAN, ITIME,
C                    ROLE, INTFLX, KOUNTS, PHI, NCH8)
C
C     DESCRIPTION OF PARAMETERS
C       MODE   - MODE OF DATA PROCESSING
C                0 PERFORM QUALITY CONTROL TESTS FOR ALL SCAN LINES
C                1 CREATE PLOTS FOR ALL SCAN LINES AND SELECTED CHANNELS
C                2 DERIVE SPECTRAL GROUND ALBEDO AND PLOT RESULTS
C                3 DERIVE SPECTRAL SIMILARITY PARAMETER USING INDIVIDUAL
C                  SCAN LINES AND PLOT RESULTS
C       NUMSCN - DIMENSION SPECIFYING THE MAXIMUM NUMBER OF SCAN LINES
C                THAT CAN BE PROCESSED
C       IPASS  - DIMENSION SPECIFYING THE MAXIMUM NUMBER OF SCAN LINE
C                SEGMENTS THAT CAN BE PROCESSED
C       ICH    - DIMENSION SPECIFYING THE MAXIMUM NUMBER OF OPTICAL
C                CHANNELS
C       IELEC  - DIMENSION SPECIFYING THE MAXIMUM NUMBER OF ELECTRICAL
C                CHANNELS
C       CALSLP - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2*MICRON*SR*V)
C       CALINT - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2*MICRON*SR)
C       ISCAN1 - ARRAY OF FIRST SCAN LINES TO BE PROCESSED
C       ISCAN2 - ARRAY OF LAST SCAN LINES TO BE PROCESSED
C       NFLT   - FLIGHT NUMBER
C       NPASS  - NUMBER OF SCAN LINE PAIRS PROCESSED
C       NSCAN  - ARRAY OF NUMBERS OF SCAN LINE SEGMENTS PROCESSED
C       KSCAN  - ARRAY OF SCAN LINE NUMBERS PROCESSED
C       ITIME  - ARRAY OF TIMES OF PROCESSED SCAN LINES
C       ROLL   - ARRAY OF ROLL ANGLES FOR PROCESSED SCAN LINES
C       INTFLX - ARRAY OF INTENSITIES OR FLUXES FOR EACH CHANNEL
C                MODE .EQ. 2
C                  UPWARD AND DOWNWARD PROPAGATING FLUXES
C                MODE .NE. 2
C                  UPWARD AND DOWNWARD PROPAGATING INTENSITIES
C       KOUNTS - ARRAY OF INSTRUMENT COUNTS FOR EACH CHANNEL
C                  COUNTS FOR THETA = 0 AND 180 DEGREES FOR EIGHT
C                  CHANNELS
C       PHI    - ARRAY OF INTENSITY OR FLUX RATIOS FOR EACH CHANNEL
C                MODE .EQ. 2
C                  RATIOS OF UPWARD AND DOWNWARD PROPAGATING FLUXES
C                MODE .NE. 2
C                  RATIOS OF UPWARD AND DOWNWARD PROPAGATING INTENSITIES
C       NCH8   - ARRAY OF FILTER POSITIONS FOR EACH SCAN LINE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       VALID8 (MODE, LSCAN, NANGS, I0, I180, AMU, LCNT2, IQUAL)
```

```
C          COMPARE EACH SET OF SCAN DATA FOR CHANNEL 2 AGAINST A
C          COSINE FUNCTION AND RETURN THE QUALITY CONTROL CATEGORY
C       INTGR8 (NUMSCN, IELEC, NSCN, K, KK, NANGS, ANGLE, VOLT,
C               CALSLP, CALINT, GAIN, INTFLX)
C          INTEGRATE INTENSITIES 0 - 90 DEGREES AND 90 - 180 DEGREES
C          TO GET DOWNWARD AND UPWARD FLUXES RESPECTIVELY
C
      SUBROUTINE CARDAT (MODE, NUMSCN, IPASS, ICH, IELEC, CALSLP,
     1                  CALINT, ISCAN1, ISCAN2, NFLT, NPASS, NSCAN,
     2                  KSCAN, ITIME, ROLL, INTFLX, KOUNTS, PHI, NCH8)
      CHARACTER*9 CHRPHI(6),BLANK,CPHI
      INTEGER*2 IDATA(3505)
      REAL*4    SLOPE,AINTER
      REAL*4    INTFLX(NUMSCN,IELEC,2)
      DIMENSION KOUNTS(NUMSCN,IELEC,2)
      DIMENSION PHI(NUMSCN,IELEC),LCOUNT(435,8),VOLT(435,8)
      DIMENSION ANGLE(435),THETA(435),AMU(435),LCNT2(435)
      DIMENSION CALSLP(*),CALINT(*),ISCAN1(*),ISCAN2(*),IERR(5)
      DIMENSION NSCAN(*),KSCAN(*),ITIME(*),ROLL(*),NCH8(*)
      EQUIVALENCE (IDATA(11),SLOPE),(IDATA(13),AINTER)
      EQUIVALENCE (LCOUNT(1,2),LCNT2(1))
      DATA        BLANK/'         '/,IERR/5*0/
      FACTR  = 180.0/(2**11)
      SIGN   = 1.0
      PI     = ACOS(-1.0)
      DEGRAD = PI/180.0
      WRITE (6,1000) MODE
      READ (5,1010) ISCAN1(1),ISCAN2(1)
      DO 10 I = 1,IPASS
         NSCAN(I) = 0
   10    CONTINUE
      NTOT   = 0
      NSUB   = 0
      NSCN   = 0
      NPASS  = 1
C
C        READ DATA FOR SINGLE SCAN LINE FROM AIRCRAFT TAPE
C
   15 IF (NSCN .EQ. NUMSCN) GO TO 50
         READ (10,1020,END=50) IDATA
         LSCAN = IDATA(5)
C
C          CHECK IF SCAN NUMBER IS BEYOND THE END OF THE CURRENT SCAN
C          NUMBER RANGE OR IF THERE HAS BEEN A SCAN NUMBER RESET
C
   20    IF (ISCAN2(NPASS) .NE. 0) THEN
            IF ((LSCAN .GT. ISCAN2(NPASS)) .OR.
     1                     (LSCAN .LT. KSCAN(NSCN))) THEN
               IF (NPASS .GE. IPASS) GO TO 50
               READ (5,1010,END=50) ISCAN1(NPASS+1),ISCAN2(NPASS+1)
               NPASS = NPASS + 1
               GO TO 20
               END IF
            END IF
C
C          NOW HANDLE RELATIONSHIP OF SCAN NUMBER TO START OF SCAN
C          NUMBER RANGE
C
```

```
      IF (ISCAN1(NPASS) .NE. 0) THEN
         IF (LSCAN .LT. ISCAN1(NPASS)) GO TO 15
         END IF
      NTOT  = NTOT + 1
      NFLT  = IDATA(10)
      NANGS = IDATA(20)
      DT    = 190.0 / (NANGS-1)
      DO 25 I = 1,NANGS
         THETA(I) = (I-1)*DT - 5.0
   25    CONTINUE
      IF (IDATA(9) .LT. 128) AROLL = IDATA(9) * FACTR
      IF (IDATA(9) .GE. 128) AROLL = (IDATA(9) - 256) * FACTR
      IF (NFLT .GE. 1139) AROLL = 4.0 * AROLL
C
C        ELIMINATE DATA FOR WHICH THE ROLL EXCEEDS 5 DEGREES OR THE
C        ZENITH MEASUREMENT OCCURS WITHIN 0.5 DEGREE OF THE START
C        SCAN PULSE
C          FLIGHTS  < 1160:  -4.5 < ROLL < 5.0 = GOOD ROLL
C          FLIGHTS 1160 ON:  -5.0 < ROLL < 4.5 = GOOD ROLL
C
      IF ((AROLL .LT. -4.5) .OR. (AROLL .GT. 5.0)) THEN
         IF (LSCAN .EQ. ISCAN2(NPASS)) GO TO 15
         GO TO 15
         END IF
C
C        CHANGE THE SIGN OF THE ROLL FOR THE CONVAIR-131A AIRCRAFT
C
      IF (NFLT .GE. 1160) AROLL = -AROLL
      LTIME = IDATA(4) + 100*IDATA(3) + 10000*IDATA(2)
      IF ((IDATA(19) .GE. 0) .AND. (IDATA(19) .LE. 2)) THEN
         IF (IDATA(19) .EQ. 0) GAIN = 0.5
         IF (IDATA(19) .EQ. 1) GAIN = 1.0
         IF (IDATA(19) .EQ. 2) GAIN = 2.0
         ELSE
            IF (LSCAN .EQ. ISCAN2(NPASS)) GO TO 15
            GO TO 15
            END IF
      NSCAN(NPASS) = NSCAN(NPASS) + 1
      NSCN         = NSCN + 1
      KSCAN(NSCN)  = IDATA(5)
      ITIME(NSCN)  = LTIME
      NCH8(NSCN)   = IDATA(6) + 7
C
C        CONVERT COUNTS TO VOLTAGE
C
      DO 35 N = 1,NANGS
         IOFF = 23 + IELEC*(N-1)
         DO 30 I = 1,IELEC
            INP         = IOFF + I
            LCOUNT(N,I) = IDATA(INP)
            VOLT(N,I)   = (LCOUNT(N,I) - AINTER) / SLOPE
   30       CONTINUE
   35    CONTINUE
C
C        LOCATE PIXELS IN THE ZENITH AND NADIR DIRECTIONS
C
      ROLL(NSCN) = AROLL
      IF (NFLT .LT. 1160) SIGN = -1.0
```

```
      EPS1   = 0.1
      EPS2   = 0.1
      DO 40 N = 1,NANGS
         ANGLE(N) = (THETA(N) + SIGN*AROLL) * DEGRAD
         AMU(N)   = COS(ANGLE(N))
         DIFF     = ABS(AMU(N) - 1.0)
         IF (DIFF .LE. EPS1) THEN
            EPS1   = DIFF
            I0     = N
            END IF
         DIFF   = ABS(AMU(N) + 1.0)
         IF (DIFF .LE. EPS2) THEN
            EPS2   = DIFF
            I180   = N
            END IF
   40    CONTINUE
C
C       QUALITY CONTROL TEST (MODE EQUALS 0 OR 3)
C         COMPARE CHANNEL 2 DATA TO COSINE FUNCTION TO DETERMINE IF
C         DATA ARE IN DIFFUSION DOMAIN
C
      IF ((MODE .EQ. 0) .OR. (MODE .GE. 3)) THEN
         CALL VALID8 (MODE, LSCAN, NANGS, I0, I180, AMU, LCNT2,
     1                IQUAL)
         NSUB             = NSUB + 1
         IERR(IQUAL+1)    = IERR(IQUAL+1) + 1
         IF (IQUAL .GT. 0) THEN
            NSCAN(NPASS) = NSCAN(NPASS) - 1
            NSCN         = NSCN - 1
            IF (LSCAN .EQ. ISCAN2(NPASS)) GO TO 15
            GO TO 15
            END IF
         END IF
C
C          CONVERT VOLTAGE TO INTENSITY OR CALCULATE UPWARD AND
C          DOWNWARD FLUXES IF MODE = 2
C
      DO 45 K = 1,IELEC
         IF ((K .EQ. 1) .OR. ((K .GT. 1) .AND. (MODE .GT. 0))) THEN
            KK = K
            IF (K  .EQ. IELEC) KK = NCH8(NSCN)
            IF ((K .EQ. IELEC) .AND. (KK .EQ. 7)) GO TO 45
            IF (MODE .NE. 2) THEN
               INTFLX(NSCN,K,1) = (VOLT(I0,K)*CALSLP(KK)   +
     1                                        CALINT(KK))   / GAIN
               INTFLX(NSCN,K,2) = (VOLT(I180,K)*CALSLP(KK) +
     1                                          CALINT(KK)) / GAIN
               ELSE
                  CALL INTGR8 (NUMSCN, IELEC, NSCN, K, KK, NANGS,
     1                         ANGLE, VOLT, CALSLP, CALINT, GAIN,
     2                         INTFLX)
                  END IF
            IF ((MODE .EQ. 1) .AND. (INTFLX(NSCN,K,1) .EQ. 0.0)) THEN
               PHI(NSCN,K) = 10.0
               ELSE
                  PHI(NSCN,K) = INTFLX(NSCN,K,2) / INTFLX(NSCN,K,1)
                  END IF
            END IF
```

```
          KOUNTS(NSCN,K,1) = LCOUNT(10,K)
          KOUNTS(NSCN,K,2) = LCOUNT(I180,K)
   45     CONTINUE
        GO TO 15
C
C       WRITE OUT SUMMARY, ERROR SUMMARY, AND PHI TABLES
C
   50 WRITE (6,1030) NTOT,NUMSCN,NSCN,NPASS
      IF (ISCAN1(1) .EQ. 0) ISCAN1(1) = KSCAN(1)
      IF (ISCAN2(NPASS) .EQ. 0) ISCAN2(NPASS) = LSCAN
      IF (MODE .EQ. 0) THEN
         IF (NFLT .LT. 1160) THEN
            R1 = -4.5
            R2 =  5.0
            ELSE
               R1 = -5.0
               R2 =  4.5
               END IF
         ISCAN2(NPASS) = LSCAN
         NROLL         = NTOT - NSUB
         WRITE (6,1040) (IERR(I),I=1,5),NROLL,R1,R2,NTOT
         END IF
      IF (MODE .GE. 2) THEN
         DO 60 I = 1,NSCN
            DO 55 J = 1,6
               CHRPHI(J) = BLANK
   55          CONTINUE
            IF (PHI(I,IELEC) .NE. 0.0) THEN
               WRITE (CPHI,1050) PHI(I,IELEC)
               ICHN = NCH8(I) - 7
               CHRPHI(ICHN) = CPHI
               END IF
            IM1 = I - 1
            IF (MOD(IM1,56) .EQ. 0) WRITE (6,1060) (K,K=1,ICH)
            WRITE (6,1070) KSCAN(I),(PHI(I,J),J=1,7),(CHRPHI(J),J=1,6)
   60       CONTINUE
         END IF
      RETURN
 1000 FORMAT(//,36H THE QUALITY CONTROL CATEGORIES ARE:,//,
     1        5H DATA,/,17H QUAL  DEFINITION,/,1X,4(1H-),2X,10(1H-),/,
     2        3X,1H0,3X,15HACCEPTABLE DATA,/,3X,1H1,3X,
     3        40HNADIR INTENSITY EXCEEDS ZENITH INTENSITY,/,
     4        3X,1H2,3X,38HNUMBER OF TIMES DEVIATIONS FROM COSINE,
     5        28H CURVE CHANGE SIGN IS .LE. 3,/,
     6        7X,32HFOR XMU BETWEEN 0.9 AND -0.9 AND,
     7        44H STANDARD DEVIATION .GT. 0.5*(STDDEV THRESH),/,
     8        3X,1H3,3X,39HSAMPLE STANDARD DEVIATION AROUND COSINE,
     9        35H CURVE EXCEEDS 5% OF MEAN AMPLITUDE,/,
     A        3X,1H4,3X,35HMAXIMUM DEVIATION FROM COSINE CURVE,
     B        30H EXCEEDS 10% OF MEAN AMPLITUDE,//,
     C        32H THE MODE OF DATA PROCESSING IS ,I1,7H WHERE:,//,
     D        55H   0 = PERFORM QUALITY CONTROL TESTS FOR ALL SCAN LINES,
     E        /,48H   1 = PLOT SELECTED CHANNELS FOR ALL SCAN LINES,/,
     F        53H   2 = DERIVE SPECTRAL GROUND ALBEDO AND PLOT RESULTS,/,
     G        49H   3 = DERIVE SPECTRAL SIMILARITY PARAMETER USING,
     H        39H INDIVIDUAL SCAN LINES AND PLOT RESULTS)
 1010 FORMAT(7I10)
 1020 FORMAT(44(80A2))
```

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1030 FORMAT(1H1,//,41H THE TOTAL NUMBER OF SCAN LINES READ IN =,I6,/,
    1        52H THE MAXIMUM NUMBER OF SCAN LINES OF VALID DATA THAT,
    2        19H CAN BE PROCESSED =,I6,/,26H THE ACTUAL NUMBER OF SCAN,
    3        32H LINES OF VALID DATA PROCESSED =,I6,/,
    4        43H THE NUMBER OF SCAN LINE GROUPS PROCESSED =,I3)
1040 FORMAT(//,49H THE NUMBER OF SCAN LINES IN EACH QUALITY CONTROL,
    1        14H CATEGORY ARE:,//,5H DATA,/,15H QUAL  NUMBER  ,
    2        10HDEFINITION,/,1X,4(1H-),2X,6(1H-),2X,10(1H-),/,3X,1H0,I8,
    3        3X,15HACCEPTABLE DATA,/,3X,1H1,I8,3X,15HNADIR INTENSITY,
    4        25H EXCEEDS ZENITH INTENSITY,/,3X,1H2,I8,3X,9HNUMBER OF,
    5        55H TIMES DEVIATIONS FROM COSINE CURVE CHANGE SIGN IS .LE.,
    6        2H 3,/,15X,41HFOR XMU BETWEEN 0.9 AND -0.9 AND STANDARD,
    7        35H DEVIATION .GT. 0.5*(STDDEV THRESH),/,3X,1H3,I8,3X,
    8        53HSAMPLE STANDARD DEVIATION AROUND COSINE CURVE EXCEEDS,
    9        21H 5% OF MEAN AMPLITUDE,/,3X,1H4,I8,3X,7HMAXIMUM,
    A        48H DEVIATION FROM COSINE CURVE EXCEEDS 10% OF MEAN,
    B        10H AMPLITUDE,/,3X,1H5,I8,3X,18HROLL OUT OF RANGE ,
    C         1H(,F4.1,9H < ROLL <,F3.1,1H),/,8X,4(1H-),/,6H TOTAL,I6)
1050 FORMAT(F9.5)
1060 FORMAT(1H1,/,6H  SCAN,13(2X,4HPHI(,I2,1H)),/,1X,5(1H-),
    1        13(2X,7(1H-)))
1070 FORMAT(I6,7F9.5,6A9)
     END
C     SUBROUTINE VALID8
C
C     PURPOSE
C       COMPARE EACH SET OF SCAN DATA FOR CHANNEL 2 AGAINST A COSINE
C       FUNCTION AND RETURN QUALITY CONTROL CATEGORY
C
C     USAGE
C       CALL VALID8 (MODE, LSCAN, NANGS, I0, I180, AMU, LCNT2, IQUAL)
C
C     DESCRIPTION OF PARAMETERS
C       MODE   - MODE OF DATA PROCESSING
C                0 PERFORM QUALITY CONTROL TESTS FOR ALL SCAN LINES
C                1 CREATE PLOTS FOR ALL SCAN LINES AND SELECTED CHANNELS
C                2 DERIVE SPECTRAL GROUND ALBEDO
C                3 DERIVE SPECTRAL SIMILARITY PARAMETER USING INDIVIDUAL
C                  SCAN LINES
C       LSCAN - SCAN LINE NUMBER
C       NANGS - NUMBER OF PIXELS IN ACTIVE SCAN
C       I0    - INDEX OF ZENITH PIXEL
C       I180  - INDEX OF NADIR PIXEL
C       AMU   - ARRAY OF THE COSINES OF THE SCAN ANGLES
C       LCNT2 - ARRAY OF THE SCAN COUNTS FOR CHANNEL 2
C       IQUAL - QUALITY CONTROL CATEGORIES
C               0 ACCEPTABLE DATA
C               1 NADIR INTENSITY EXCEEDS ZENITH INTENSITY
C               2 NUMBER OF TIMES DEVIATIONS FROM COSINE CURVE CHANGE
C                   SIGN IS .LE. 3, FOR XMU BETWEEN 0.9 AND -0.9 AND
C                   STANDARD DEVIATION .GT. 0.5*(STDDEV THRESH)
C               3 SAMPLE STANDARD DEVIATION AROUND COSINE CURVE
C                   EXCEEDS 5% OF MEAN AMPLITUDE
C               4 MAXIMUM DEVIATION FROM COSINE CURVE EXCEEDS 10% OF
C                   MEAN AMPLITUDE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
```

```
C
      SUBROUTINE VALID8 (MODE, LSCAN, NANGS, I0, I180, AMU, LCNT2,
     1                   IQUAL)
      DIMENSION AMU(*),LCNT2(*)
      DATA NPASS/0/
      IQUAL  = 0
      NPASS  = NPASS + 1
C
C        FIND THE CHARACTERISTICS OF THE COSINE FUNCTION THROUGH THE
C        ZENITH/NADIR ENDPOINTS
C
      NPTS   = I180 - I0 + 1
      NPTSM2 = NPTS - 2
      LCNTMX = LCNT2(I0) + LCNT2(I0+1)
      AMUMX  = AMU(I0)   + AMU(I0+1)
      IDIV   = 2
      IF (I0 .GT. 1) THEN
         LCNTMX = LCNTMX + LCNT2(I0-1)
         AMUMX  = AMUMX  + AMU(I0-1)
         IDIV   = 3
         END IF
      LCNTMX = LCNTMX / IDIV
      AMUMX  = AMUMX  / IDIV
      LCNTMN = LCNT2(I180) + LCNT2(I180-1)
      AMUMN  = AMU(I180)   + AMU(I180-1)
      IDIV   = 2
      IF (I180 .LT. NANGS) THEN
         LCNTMN = LCNTMN + LCNT2(I180+1)
         AMUMN  = AMUMN  + AMU(I180+1)
         IDIV   = 3
         END IF
      LCNTMN = LCNTMN / IDIV
      AMUMN  = AMUMN / IDIV
      COSSLP = (LCNTMX - LCNTMN)/(AMUMX - AMUMN)
      AMPLMN = (LCNTMX + LCNTMN)/2.0
C
C        COMPARE THE DEVIATION STATISTICS OF THE DATA FROM THE COSINE
C        FUNCTION WITH THE QUALITY CONTROL TESTS
C
      SDEVMX = 0.05 * AMPLMN
      DEVMAX = 0.0
      DEVMIN = 0.0
      SUM    = 0.0
      SUM2   = 0.0
      NCHNGE = 0
      IF (COSSLP .LE. 0.0) IQUAL = 1
      DO 10 I = 1,NPTSM2
         DEVI8  = LCNT2(I0+I) - LCNTMN -
     1                          COSSLP*(AMU(I0+I) - AMUMN)
         IF (DEVI8 .GT. DEVMAX) DEVMAX = DEVI8
         IF (DEVI8 .LT. DEVMIN) DEVMIN = DEVI8
         IF (I .GT. 1) THEN
            IF ((AMU(I0+I) .LE. 0.9) .AND.
     1          (AMU(I0+I) .GE. -0.9)) THEN
               IF (DEVI8*DEV8M1 .LT. 0.0) NCHNGE = NCHNGE + 1
               END IF
            END IF
         SUM    = SUM  + DEVI8
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```
         SUM2   = SUM2 + DEVI8*DEVI8
         DEVI8M1 = DEVI8
   10    CONTINUE
      ARTHMN = SUM / NPTSM2
      STNDEV = SQRT(SUM2 / NPTSM2)
      IF (STNDEV .GT. 0.5*SDEVMX) THEN
         IF (NCHNGE .LE. 3) THEN
            IF (IQUAL .EQ. 0) IQUAL = 2
            END IF
         END IF
      IF (STNDEV .GT. SDEVMX) THEN
         IF (IQUAL .EQ. 0) IQUAL = 3
         END IF
      IF ((DEVMAX .GT.  2.0*SDEVMX) .OR.
     1    (DEVMIN .LT. -2.0*SDEVMX)) THEN
         IF (IQUAL .EQ. 0) IQUAL = 4
         END IF
C
C       WRITE OUT RESULTS
C
      IF (MODE .NE. 0) GO TO 999
      IF ((NPASS .EQ. 1) .OR. (MOD(NPASS,52) .EQ. 0)) WRITE (6,1000)
      WRITE (6,1010) NPASS,LSCAN,I0,I180,COSSLP,SDEVMX,DEVMAX,DEVMIN,
     1               ARTHMN,NCHNGE,STNDEV,IQUAL
  999 RETURN
 1000 FORMAT(1H1,//,
     1       29X,19HZENITH / NADIR CASE,/,18X,5HPIXEL,/,
     2        9X,4HSCAN,5X,5HINDEX,14X,6HSTDDEV,10X,9HDEVIATION,
     3       14X,6HSAMPLE,2X,4HDATA,/,2(1X,6HNUMBER),
     4       10H   ZEN NAD,4X,5HSLOPE,4X,6HTHRESH,6X,3HMAX,5X,
     5        3HMIN,4X,4HMEAN,2X,3H+/-,3X,6HSTDDEV,2X,4HQUAL,/,
     6        2(1X,6(1H-)),3X,7(1H-),4X,5(1H-),4X,6(1H-),4X,21(1H-),
     7        2X,3(1H-),3X,6(1H-),2X,4(1H-),/)
 1010 FORMAT(I6,2I7,I4,F9.1,F10.2,F9.1,2F8.1,I5,F9.2,I5)
      END
C     SUBROUTINE INTGR8
C
C     PURPOSE
C       INTEGRATE INTENSITIES TO GET UPWARD AND DOWNWARD PROPAGATING
C       FLUXES AND STORE IN INTFLX(NSCN,IELEC,2) AND
C       INTFLX(NSCN,IELEC,1) RESPECTIVELY
C
C     USAGE
C       CALL INTGR8 (NUMSCN, IELEC, NSCN, K, KK, NANGS, ANGLE,
C                    VOLT, CALSLP, CALINT, GAIN, INTFLX)
C
C     DESCRIPTION OF PARAMETERS
C       NUMSCN - DIMENSION SPECIFYING THE MAXIMUM NUMBER OF SCAN LINES
C                THAT CAN BE PROCESSED
C       IELEC  - DIMENSION SPECIFYING THE MAXIMUM NUMBER OF ELECTRICAL
C                CHANNELS
C       NSCN   - CURRENT SCAN INDEX
C       K      - ELECTRICAL CHANNEL INDEX
C       KK     - SPECTRAL CHANNEL INDEX
C       NANGS  - NUMBER OF PIXELS (ANGLES) IN THE ACTIVE SCAN
C       ANGLE  - ARRAY OF THE PIXEL SCAN ANGLES (RADIANS)
C       VOLT   - ARRAY OF THE VOLTAGES FOR EACH PIXEL
C       CALSLP - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2*MICRON*SR*V)
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C        CALINT - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2*MICRON*SR)
C        GAIN   - GAIN USED IN CALCULATING THE INTENSITY
C        INTFLX - ARRAY OF INTENSITIES OR FLUXES FOR EACH CHANNEL
C                 MODE .EQ. 2
C                   UPWARD AND DOWNWARD PROPAGATING FLUXES
C                 MODE .NE. 2
C                   UPWARD AND DOWNWARD PROPAGATING INTENSITIES
C
C      SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C        NONE
C
      SUBROUTINE INTGR8 (NUMSCN, IELEC, NSCN, K, KK, NANGS, ANGLE,
     1                  VOLT, CALSLP, CALINT, GAIN, INTFLX)
      REAL*4     INTFLX(NUMSCN,IELEC,2),INTEN(435)
      DIMENSION VOLT(435,8)
      DIMENSION ANGLE(435),ANU2(435)
      DIMENSION CALSLP(*),CALINT(*)
      PI      = ACOS(-1.0)
      DO 10 I = 1,NANGS
         INTEN(I) = (VOLT(I,K)*CALSLP(KK) + CALINT(KK)) / GAIN
         INTEN(I) = (VOLT(I,K)*CALSLP(KK) + CALINT(KK)) / GAIN
   10    CONTINUE
C
C        FIND INDEX FOR ANGLE CLOSEST TO, BUT .GE., 0    RADIANS (I0)
C        FIND INDEX FOR ANGLE CLOSEST TO, BUT .GE., PI/2 RADIANS (I90)
C        FIND INDEX FOR ANGLE CLOSEST TO, BUT .LE., PI   RADIANS (I180)
C        DO ONLY FOR FIRST PASS FOR THIS SCAN (I.E. CHANNEL 1)
C
      IF (K .EQ. 1) THEN
         I0     = 0
         I90    = 0
         I180   = 0
         ANG    = 0.0
         ANG0   = 0.0
         ANG90  = 0.0
         ANG180 = 0.0
         DO 20 I = 1,NANGS
            ANU2(I)  = SIN(2.0*ANGLE(I))
            IF (ANGLE(I) .GE. ANG) THEN
               IF (I0 .EQ. 0) THEN
                  ANG0 = ANGLE(I)
                  I0   = I
                  ELSE
                     IF (I90 .EQ. 0) THEN
                        ANG90 = ANGLE(I)
                        I90   = I
                        ELSE
                           ANG180 = ANGLE(I)
                           I180   = I
                           END IF
                  END IF
               ANG = ANG + PI/2.0
               END IF
   20       CONTINUE
         END IF
C
C        INTEGRATE INTENSITIES BY TRAPEZOIDAL RULE
C
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      DELANG = (ANGLE(NANGS) - ANGLE(1)) / (NANGS - 1)
      I90M = I90 - 1
      IF (ANG90 .EQ. PI/2.0) I90M = I90
      FLXTRN = (INTEN(I0)*ANU2(I0) + INTEN(I90M)*ANU2(I90M)) / 2.0
      DO 30 I = I0+1,I90M-1
         FLXTRN = FLXTRN + INTEN(I)*ANU2(I)
   30    CONTINUE
      FLXREF = (INTEN(I90)*ANU2(I90) + INTEN(I180)*ANU2(I180)) / 2.0
      DO 40 I = I90+1,I180-1
         FLXREF = FLXREF + INTEN(I)*ANU2(I)
   40    CONTINUE
      FLXTRN = FLXTRN * PI * DELANG
      FLXREF = FLXREF * PI * DELANG
C
C       ADD ON EXTRAPOLATED END POINTS
C
      DELA0  = ANG0
      DELA90 = (PI / 2.0) - ANGLE(I90M)
      FLXTRN = FLXTRN + (INTEN(I0)*ANU2(I0)*DELA0 +
     1                   INTEN(I90M)*ANU2(I90M)*DELA90) * PI / 2.0
      DELA90 = ANG90 - (PI / 2.0)
      DEL180 = PI - ANG180
      FLXREF = FLXREF + (INTEN(I90)*ANU2(I90)*DELA90 +
     1                   INTEN(I180)*ANU2(I180)*DEL180) * PI / 2.0
      FLXREF = - FLXREF
      INTFLX(NSCN,K,1) = FLXTRN
      INTFLX(NSCN,K,2) = FLXREF
  999 RETURN
      END
C     SUBROUTINE STDEV
C
C     PURPOSE
C       FIND MEAN AND STANDARD DEVIATION OF X ARRAY
C
C     USAGE
C       SUBROUTINE STDEV (X, NX, XBAR, SIGX)
C
C     DESCRIPTION OF PARAMETERS
C       X    - ARRAY FOR WHICH THE MEAN AND STANDARD DEVIATION ARE TO BE
C              FOUND
C       NX   - NUMBER OF ELEMENTS IN X ARRAY
C       XBAR - ARITHMETIC MEAN OF X ARRAY
C       SIGX - STANDARD DEVIATION OF X ARRAY
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
C
      SUBROUTINE STDEV (X, NX, XBAR, SIGX)
      DIMENSION X(*)
      SUMX  = 0.0
      SUMX2 = 0.0
      DO 10 N = 1,NX
         SUMX  = SUMX  + X(N)
         SUMX2 = SUMX2 + X(N)*X(N)
   10    CONTINUE
      XBAR = SUMX  / NX
      SIGX = SUMX2 - NX*XBAR*XBAR
      IF (SIGX .LT. 0.0) SIGX = 0.0
```

```
      SIGX = SQRT(SIGX / (NX - 1.0))
      RETURN
      END
C     SUBROUTINE FINDS
C
C     PURPOSE
C       INTERPOLATE S AND PHI ARRAYS USING SPLINE UNDER TENSION
C
C     USAGE
C       SUBROUTINE FINDS (TSTAR, PHIBAR, AG, SVAL)
C
C     DESCRIPTION OF PARAMETERS
C       TSTAR  - (1 - G)*(TAUC - TAU) FROM CONSERVATIVE CHANNEL (1 OR 2)
C       PHIBAR - MEAN VALUE OF I(-1) / I(1)
C       AG     - GROUND ALBEDO
C       SVAL   - SIMILARITY PARAMETER
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       QPHI (S, AG, T)
C          DETERMINES PHI AS A FUNCTION OF S FOR FIXED VALUES OF AG
C          AND T
C       SPLINT (N, X, F, W, IOP, COSECH, A, B, SIGMA, Y)
C          DETERMINES THE PARAMETERS NECESSARY TO COMPUTE AN INTERPOLA-
C          TORY SPLINE UNDER TENSION THROUGH A SEQUENCE OF FUNCTIONAL
C          VALUES
C       INTERT (N, X, F, W, COSECH, SIGMA, XBAR, TAB)
C          INTERPOLATES A CURVE AT A GIVEN POINT USING A SPLINE UNDER
C          TENSION
C
      SUBROUTINE FINDS (TSTAR, PHIBAR, AG, SVAL)
      DIMENSION F(103),X(103),Y(103),W(103),A(104),B(103),COSECH(103)
      DIMENSION IOP(2),TAB(3)
      DATA      IOP/2*5/
      SIGMA = 1.0
C
C       COMPUTE SIMILARTITY PARAMETER AS A FUNCTION OF PHI
C
      NS    = 100
      DELS  = 1.0 / NS
      DO 10 I = 2,NS
         F(NS+1-I) = (I-1)*DELS
         X(NS+1-I) = QPHI(F(NS+1-I),AG,TSTAR)
   10    CONTINUE
      DO 15 I = 1,4
         F(NS+4-I) = (I-1)*0.001
         X(NS+4-I) = QPHI(F(NS+4-I),AG,TSTAR)
   15    CONTINUE
      NS     = NS + 3
      CALL SPLINT (NS, X, F, W, IOP, COSECH, A, B, SIGMA, Y)
      CALL INTERT (NS, X, F, W, COSECH, SIGMA, PHIBAR, TAB)
      SVAL   = TAB(1)
      RETURN
      END
C     FUNCTION QPHI
C
C     PURPOSE
C       DETERMINES PHI AS A FUNCTION OF S FOR FIXED VALUES OF AG
C       AND T
```

```
C
C     USAGE
C       FUNCTION QPHI (S, AG, T)
C
C     DESCRIPTION OF PARAMETERS
C       S  - SIMILARITY PARAMETER
C       AG - GROUND ALBEDO
C       T  - (1 - G) * (TAUC - TAU)
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
C
      FUNCTION QPHI (S, AG, T)
      QP    = 0.714
      IF (S .GT. 0.0) GO TO 10
C
C       CONSERVATIVE SCATTERING
C
      ANUM  = 3.0 * (1.0 - AG) * (T + QP - 1.0) + 4.0*AG
      ADEN  = 3.0 * (1.0 - AG) * (T + QP + 1.0) + 4.0*AG
      QPHI  = ANUM / ADEN
      GO TO 20
C
C       NONCONSERVATIVE SCATTERING
C
   10 SM1   = 1.0 - S
      TWOT  = 2.0 * T
      ASTAR = (1.0 - 0.14638*S) * SM1 / (1.0 + 1.1629*S)
      D     = (1.0 - 0.98742*S) * SM1 / (1.0 + 1.4767*S)
      AL    = (1.0 - 0.68128*S) * SM1 / (1.0 + 0.79192*S)
      AN2   = (1.0 + 0.41416*S) * SM1 / (1.0 + 1.8877*S)
      BM    = (1.0 + 1.8*S - 7.087*S*S + 4.74*S*S*S)/
     1                                 ((1.0 - 0.819*S) * SM1 * SM1)
      AM    = (1.0 + 1.537*S) * ALOG(BM)
      AM1   = 1.0 - AG*ASTAR
      Z1    = (1.0 + 2.0785*S) * SM1 / (1.0 + 2.8162*S)
      P     = 1.0 + 0.44257*S
      Z1    = Z1**P
      Z     = Z1**TWOT
      ANUM  = AM1 * (D - AL*Z) + AG*AM*AN2*Z
      ADEN  = AM1 * (1.0 - D*AL*Z) + AG*AM*AN2*D*Z
      QPHI  = ANUM / ADEN
   20 RETURN
      END
C     SUBROUTINE SPLINT
C
C     PURPOSE
C       DETERMINES THE PARAMETERS NECESSARY TO COMPUTE AN INTERPOLATORY
C       SPLINE UNDER TENSION THROUGH A SEQUENCE OF FUNCTIONAL VALUES
C
C     USAGE
C       CALL SPLINT (N, X, F, W, IOP, COSECH, A, B, SIGMA, Y)
C
C     DESCRIPTION OF PARAMETERS
C       N       - NUMBER OF POINTS IN X AND F ARRAYS
C       X       - ARRAY CONTAINING INDEPENDENT VARIABLE
C       F       - ARRAY CONTAINING DEPENDENT VARIABLE
C       W       - ARRAY OF 2ND DERIVATIVE VALUES
```

```
C        IOP    - ARRAY WHICH DEFINES BOUNDARY CONDITIONS TO BE USED
C                 1 2ND DERIVATIVE
C                 2 RUN OUT AT BOUNDARY
C                 3 1ST DERIVATIVE
C                 4 PERIODIC
C                 5 1ST DERIVATIVE CALCULATED FROM 4 POINT INTERPOLATION
C        COSECH - HYPERBOLIC FUNCTION ARRAY
C                 COSECH(I) = 1. / SINH(SIG * (X(I) - X(I-1)))
C        A      - ARRAY CONTAINING OFF-DIAGONAL ELEMENTS
C        B      - ARRAY CONTAINING DIAGONAL ELEMENTS
C        SIGMA  - NORMALIZED TENSION PARAMETER
C        Y      - ARRAY CONTAINING RIGHT HAND SIDE OF TRIDIAGONAL SYSTEM
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C        TRIDIP (N, A, B, C, Y, W)
C           INVERTS TRIDIAGONAL MATRIX IN ORDER TO SOLVE THE SYSTEM OF
C           LINEAR EQUATIONS GIVING THE 2ND DERIVATIVE VALUES
C
C     COMMENTS
C        X, F, W, COSECH, B, Y ARRAYS MUST BE DIMENSIONED .GE. N
C        A ARRAY MUST BE DIMENSIONED .GE. N+1
C        IF IOP(1) < 4, W(1) MUST CONTAIN SPECIFIED BOUNDARY CONDITION
C        IF IOP(2) < 4, W(N) MUST CONTAIN SPECIFIED BOUNDARY CONDITION
C
      SUBROUTINE SPLINT (N, X, F, W, IOP, COSECH, A, B, SIGMA, Y)
      DIMENSION X(N),F(N),W(N),IOP(2),COSECH(N),A(N),B(N),Y(N)
C
C        DENORMALIZE TENSION FACTOR
C
      SIG   = SIGMA * FLOAT(N-1) / (X(N) - X(1))
      SIG2  = SIG * SIG
      SIG2R = 1.0 / SIG2
      SIGR  = 1.0 / SIG
      WN = W(N)
      DO 5 I = 2,N
         SIGH  = SIG*(X(I)-X(I-1))
         SIGHR = 1.0/SIGH
         EXPX  = EXP(SIGH)
         COSECH(I) = 2.0 / (EXPX - 1.0/EXPX)
         A(I) = SIGHR - COSECH(I)
         B(I) = SQRT(1.0 + COSECH(I)**2) - SIGHR
         Y(I) = (F(I) - F(I-1)) * SIGHR
    5    CONTINUE
      NN = N
C
C        SELECT BOUNDARY CONDITION APPROPRIATE TO BOUNDARY 1
C
      MK = IOP(1)
      GO TO (10,15,20,25,30), MK
   10 W(1) = W(1) * SIG2R
      Y(2) = Y(3) - Y(2) - A(2)*W(1)
      A(2) = 0.0
      B(2) = B(2) + B(3)
      I1   = 2
      NN   = NN - 1
      GO TO 35
   15 Y(2) = Y(3) - Y(2)
      B(2) = B(2) +B(3) + W(1)*A(2)
```

```
      A(2) = 0.0
      I1   = 2
      NN   = NN - 1
      GO TO 35
   20 Y(1) = Y(2) - W(1)*SIGR
      Y(2) = Y(3) - Y(2)
      A(1) = 0.0
      B(1) = B(2)
      B(2) = B(2) + B(3)
      I1   = 1
      GO TO 35
   25 Y2   = Y(2)
      B2   = B(2)
      Y(2) = Y(3) - Y(2)
      B(2) = B(2) + B(3)
      I1   = 2
      NN   = NN - 1
      GO TO 35
   30 A1   = X(1) - X(2)
      A2   = X(1) - X(3)
      A3   = X(1) - X(4)
      A4   = X(2) - X(3)
      A5   = X(2) - X(4)
      A6   = X(3) - X(4)
      W(1) = F(1) * (1.0/A1 + 1.0/A2 + 1.0/A3)
     1     - A2*A3*F(2) / (A1*A4*A5) + A1*A3*F(3) / (A2*A4*A6)
     2     - A1*A2*F(4) / (A3*A5*A6)
      GO TO 20
C
C        COMPUTE B AND Y ARRAYS
C
   35 I2 = N - 2
      DO 40 I = 3,I2
         Y(I) = Y(I+1) - Y(I)
         B(I) = B(I) + B(I+1)
   40    CONTINUE
C
C        SELECT BOUNDARY CONDITION APPROPRIATE TO BOUNDARY 2
C
      ML = IOP(2)
      GO TO (45,50,55,60,65), ML
   45 WN = WN * SIG2R
      Y(N-1) =  Y(N) - Y(N-1) - A(N)*WN
      A(N)   =  0.0
      B(N-1) =  B(N-1) + B(N)
      NN     =  NN - 1
      GO TO 70
   50 Y(N-1) =  Y(N) - Y(N-1)
      B(N-1) =  B(N-1) + B(N) + WN*A(N)
      A(N)   =  0.0
      NN     =  NN - 1
      GO TO 70
   55 Y(N-1) =  Y(N) - Y(N-1)
      Y(N)   = -Y(N) + WN*SIGR
      B(N-1) =  B(N-1) + B(N)
      A(N+1) =  0.0
      GO TO 70
   60 Y(N-1) =  Y(N) - Y(N-1)
```

```
      Y(N)   =  Y2 - Y(N)
      B(N-1) =  B(N-1) + B(N)
      B(N)   =  B(N) + B2
      A(N+1) =  A(2)
      GO TO 70
   65 B1 = X(N) - X(N-3)
      B2 = X(N) - X(N-2)
      B3 = X(N) - X(N-1)
      B4 = X(N-1) - X(N-3)
      B5 = X(N-1) - X(N-2)
      B6 = X(N-2) - X(N-3)
      WN = - B2*B3*F(N-3) / (B6*B4*B1) + B1*B3*F(N-2) / (B6*B5*B2)
     1     - B1*B2*F(N-1) / (B4*B5*B3)
     2     + F(N) * (1.0/B1 + 1.0/B2 + 1.0/B3)
      GO TO 55
   70 CALL TRIDIP (NN, A(I1), B(I1), A(I1+1), Y(I1), W(I1))
      GO TO (85,75,85,80,85), MK
   75 W(1) = W(1) * W(2)
      GO TO 85
   80 W(1) = W(N)
   85 GO TO (90,95,999,999,999), ML
   90 W(N) = WN
      GO TO 999
   95 W(N) = W(N-1) * WN
  999 RETURN
      END
C     SUBROUTINE TRIDIP
C
C     PURPOSE
C       INVERTS A TRIDIAGONAL MATRIX IN ORDER TO SOLVE THE SYSTEM OF
C       LINEAR EQUATIONS GIVING THE SECOND DERIVATIVES FOR A SPLINE
C       UNDER TENSION
C
C     USAGE
C       CALL TRIDIP (N, A, B, C, Y, W)
C
C     DESCRIPTION OF PARAMETERS
C       N      - DIMENSION OF TRIDIAGONAL MATRIX
C       A      - ARRAY CONTAINING OFF-DIAGONAL ELEMENTS
C       B      - ARRAY CONTAINING DIAGONAL ELEMENTS
C       C      - ARRAY CONTAINING OFF-DIAGONAL ELEMENTS
C       Y      - ARRAY CONTAINING RIGHT HAND SIDE OF TRIDIAGONAL SYSTEM
C       W      - ARRAY OF 2ND DERIVATIVE VALUES COMPUTED
C
      SUBROUTINE TRIDIP (N, A, B, C, Y, W)
      DIMENSION A(N),B(N),C(N),Y(N),W(N),D(201),Z(201),U(201)
      AN   =  A(N)
      YN   =  Y(N)
      NM3  =  N - 3
      D(1) =  C(1) / B(1)
      Z(1) =  Y(1) / B(1)
      V    =  C(N)
      U(1) =  A(1) / B(1)
      DO 5 J = 2,NM3
         DEN  =  B(J) - A(J)*D(J-1)
         D(J) =  C(J) / DEN
         U(J) = -A(J) * U(J-1) / DEN
         Z(J) =  (Y(J) - A(J)*Z(J-1)) / DEN
```

```
         AN   =  AN - V*U(J)
         YN   =  YN - V*Z(J)
         V    =  -V * D(J)
    5    CONTINUE
      DEN    = B(N-2) - A(N-2)*D(N-3)
      D(N-2) = (C(N-2) - A(N-2)*U(N-3)) / DEN
      Z(N-2) = (Y(N-2) - A(N-2)*Z(N-3)) / DEN
      AN     = AN - V*D(N-2)
      YN     = YN - V*Z(N-2)
      DEN    = B(N-1) - A(N-1)*D(N-2)
      D(N-1) = C(N-1) / DEN
      Z(N-1) = (Y(N-1) - Z(N-2)*A(N-1)) / DEN
      W(N)   = (YN - AN*Z(N-1)) / (B(N) - AN*D(N-1))
      W(N-1) = Z(N-1) - D(N-1)*W(N)
      W(N-2) = Z(N-2) - D(N-2)*W(N-1)
      NM     = N - 1
      DO 10 J = 3,NM
         K    = N - J
         W(K) = Z(K) - D(K) * W(K+1) - U(K)*W(N-1)
   10    CONTINUE
      RETURN
      END
C     SUBROUTINE INTERT
C
C     PURPOSE
C       INTERPOLATES A CURVE AT A GIVEN POINT USING A SPLINE UNDER
C       TENSION
C
C     USAGE
C       CALL INTERT (N, X, F, W, COSECH, SIGMA, XBAR, TAB)
C
C     DESCRIPTION OF PARAMETERS
C       N       - NUMBER OF POINTS IN F AND X ARRAYS
C       X       - ARRAY CONTAINING INDEPENDENT VARIABLE
C       F       - ARRAY CONTAINING DEPENDENT VARIABLE
C       W       - ARRAY OF 2ND DERIVATIVE VALUES CALCULATED BY SPLINT
C       COSECH  - HYPERBOLIC FUNCTION ARRAY COMPUTED BY SPLINT:
C                 COSECH(I) = 1. / SINH(SIG * (X(I) - X(I-1)))
C       SIGMA   - NORMALIZED TENSION PARAMETER USED BY SPLINT
C       XBAR    - POINT AT WHICH INTERPOLATION IS REQUIRED
C       TAB     - ARRAY OF DIMENSION 3 CONTAINING THE RETURNED FUNCTION,
C                 1ST DERIVATIVE, AND 2ND DERIVATIVE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C        SEARCH (XBAR, X, N, I)
C          LOCATES SPLINE UNDER TENSION SEGMENT CONTAINING XBAR
C
C     COMMENTS
C       X, F, W, COSECH ARRAYS MUST BE DIMENSIONED .GE. N
C
      SUBROUTINE INTERT (N, X, F, W, COSECH, SIGMA, XBAR, TAB)
      DIMENSION X(N),F(N),W(N),COSECH(N),TAB(3)
C
C       DENORMALIZE TENSION FACTOR
C
      SIG = SIGMA*FLOAT(N-1)/(X(N) - X(1))
C
C       LOCATE XBAR IN TABLE.  IF XBAR IS OUTSIDE RANGE OF TABLE,
```

```
C        EXTRAPOLATION TAKES PLACE.
C
      IF(XBAR - X(1)) 10,10,15
   10 I = 1
      GO TO 30
   15 IF(XBAR - X(N)) 25,20,20
   20 I = N - 1
      GO TO 30
   25 CALL SEARCH (XBAR, X, N, I)
   30 FLK  = X(I+1) - X(I)
      RFLK = 1.0 / FLK
C
C        CALCULATE F(XBAR)
C
      XI      =  XBAR - X(I)
      XIP1    =  X(I+1) - XBAR
      EXPX    =  EXP(SIG*XI)
      EXPXP1 =  EXP(SIG*XIP1)
      SINH    =  0.5 * (EXPX - 1.0/EXPX)
      COSH    = -SINH + EXPX
      SINHP1 =  0.5 * (EXPXP1 - 1.0/EXPXP1)
      COSHP1 = -SINHP1 + EXPXP1
      A       =  (W(I)*SINHP1 + W(I+1)*SINH) * COSECH(I+1)
      B       =  (F(I+1) - W(I+1))*XI + (F(I) - W(I))*XIP1
      TAB(1) =  A + B*RFLK
C
C        CALCULATE 2ND DERIVATIVE AT XBAR
C
      TAB(3) =  A * SIG**2
C
C        CALCULATE 1ST DERIVATIVE AT XBAR
C
      A       = SIG*(W(I+1) * COSH-W(I)*COSHP1) * COSECH(I+1)
      B       = (F(I+1) - W(I+1) - F(I) + W(I)) * RFLK
      TAB(2) = A + B
      RETURN
      END
C     SUBROUTINE SEARCH
C
C     PURPOSE
C       LOCATE POSITION IN TABLE OF POINT AT WHICH INTERPOLATION IS
C       REQUIRED
C
C     USAGE
C       CALL  SEARCH (XBAR, X, N, I)
C
C     DESCRIPTION OF PARAMETERS
C       XBAR   - POINT AT WHICH INTERPOLATION IS REQUIRED
C       X      - ARRAY CONTAINING INDEPENDENT VARIABLE
C       N      - NUMBER OF POINTS IN X ARRAY
C       I      - INDEX SPECIFYING SEGMENT CONTAINING XBAR
C
      SUBROUTINE  SEARCH (XBAR, X, N, I)
      DIMENSION X(N),COM1(6),COM2(6)
      DATA B/.69314718/
      IF (N .LT. 2) GO TO 20
      IF (X(1) .GT. X(2)) GO TO 25
      M = INT(ALOG(FLOAT(N)) / B)
```

```
      I = 2**M
      K = I
   10 K = K / 2
      IF ((XBAR .GE. X(I)) .AND. (XBAR .LT. X(I+1))) RETURN
      IF (XBAR .GT. X(I)) GO TO 15
      I = I - K
      GO TO 10
   15 I = I + K
      IF (I .LE. N) GO TO 10
      I = N
      GO TO 10
   20 WRITE (6,1000)
      RETURN
   25 WRITE (6,1010)
      RETURN
 1000 FORMAT(28H SEARCH   N IS LESS THAN 2.0)
 1010 FORMAT(42H SEARCH   TABLE IS NOT IN INCREASING ORDER)
      END
C     SUBROUTINE SEZMXY
C
C     PURPOSE
C       MAKE AN X-Y PLOT MIXING CURVES AND SYMBOLS, OR JUST SYMBOLS
C       ALONE, OR JUST CURVES ALONE, USING NCAR AUTOGRAPH ROUTINES
C
C     USAGE
C       CALL SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY, IDXY, LTYP,
C                    LROW, LBAC, NPAT, SYMBOL, XMIN, XMAX, YMIN,
C                    YMAX)
C
C     DESCRIPTION OF PARAMETERS
C       LABG   - GRAPH LABEL (CHARACTER VARIABLE, .LE. 60 CHARACTERS,
C                ENDING IN $ IF .LT. 60)
C       LABX   - X-AXIS LABEL (CHARACTER VARIABLE LIKE -LABG-)
C       LABY   - Y-AXIS LABEL (LIKE -LABX-)
C       X      - X-COORDINATES OF POINTS TO BE PLOTTED (DOUBLE PREC.)
C                1-D ARRAY FOR ALL CURVES IF LROW = 1, OF DIMENSION AT
C                LEAST
C
C                            MAX      ( NPTS(K) )
C                        K=1,...,MANY
C
C                OTHERWISE 2-D ARRAY WITH 1ST DIMENSION -IDXY-, 2ND
C                DIMENSION AT LEAST -MANY- (1ST DIMENSION IS POINT
C                NUMBER, 2ND IS CURVE NUMBER).
C       Y      - Y-COORDINATES OF POINTS TO BE PLOTTED (DOUBLE PREC.)
C                1-D ARRAY IF MANY = 1, OF DIMENSION AT LEAST
C
C                            MAX      ( NPTS(K) )
C                        K=1,...,MANY
C
C                OTHERWISE 2-D ARRAY WITH 1ST DIMENSION -IDXY-, 2ND
C                DIMENSION AT LEAST -MANY- (1ST DIMENSION IS POINT
C                NUMBER, 2ND IS CURVE NUMBER).
C       NPTS   - ARRAY CONTAINING NUMBER OF POINTS TO BE PLOTTED FOR
C                EACH CURVE;  E.G. -NPTS(K)- IS THE NUMBER OF POINTS IN
C                CURVE -K-
C       MANY   - NUMBER OF CURVES TO BE PLOTTED
C       IDXY   - 1ST DIMENSION OF -Y- (AND, IF LROW = 2, OF -X-)
```

```
C       LTYP   - SPECIFIES TYPE OF PLOT
C                1 LINEAR X-AXIS, LINEAR Y-AXIS
C                2 LINEAR X-AXIS, LOG    Y-AXIS
C                3 LOG    X-AXIS, LINEAR Y-AXIS
C                4 LOG    X-AXIS, LOG    Y-AXIS
C       LROW   - SPECIFIES DIMENSION OF X ARRAY
C                1 -X- IS SINGLY DIMENSIONED (ALL CURVES HAVE SAME
C                     X-ARRAY)
C                2 -X- IS DOUBLY DIMENSIONED (EACH CURVE HAS ITS OWN
C                     X-ARRAY)
C       LBAC   - SPECIFIES BACKGROUND OF GRAPH
C                1 PERIMETER BACKGROUND
C                2 GRID BACKGROUND (SAME AS 1 BUT TICKMARKS CONNECTED)
C                3 HALF-AXIS BACKGROUND
C                4 NO BACKGROUND
C       NPAT   - SPECIFIES PATTERN OF SUCCESSIVE CURVES
C                1-6 FIRST CURVE FOR WHICH SYMBOL = 'L' USES THE INTER-
C                    NAL DASHED-LINE PATTERN -DSHL(NPAT)-.  OTHER CURVES
C                    USE SUCCESSIVE PATTERNS IN -DSHL- CYCLICALLY,
C                    REPEATING AFTER THE SIXTH PATTERN.  THE DEFAULT
C                   -DSHL- CONTAINS:
C                     DSHL(1) = SOLID LINE, DSHL(2) = DOTTED LINE,
C                     DSHL(3) = LONG-DASH LINE, AND 3 MORE DOT-DASH
C                     PATTERNS;  THE USER MAY REPLACE IT AT WILL.
C                 <0 USES SOLID LINES WITH LETTERS EMBEDDED:  THE FIRST
C                    LETTER USED IS THE ONE WITH NUMBER ABS(NPAT) IN THE
C                    ALPHABET.  OTHER CURVES USE SUCCESSIVE LETTERS,
C                    CYCLING BACK TO 'A' AFTER 'Z' IS USED.
C       SYMBOL - AN ARRAY OF SINGLE CHARACTERS, ONE FOR EACH CURVE;
C                IF SYMBOL(K) = 'L', THEN CURVE -K- IS PLOTTED AS A
C                LINE WITH PATTERN DETERMINED BY 'NPAT'; OTHERWISE IT
C                IS PLOTTED AS UNCONNECTED SYMBOLS AT THE DATA POINTS,
C                USING -SYMBOL(K)- AS THE PLOTTING SYMBOL (TO GET DOTS,
C                AS IN A SCATTERPLOT, USE A PERIOD).
C       XMIN   - MIN VALUE ALONG X-AXIS (DOUBLE PRECISION)
C       XMAX   - MAX VALUE ALONG X-AXIS (DOUBLE PRECISION)
C       YMIN   - MIN VALUE ALONG Y-AXIS (DOUBLE PRECISION)
C       YMAX   - MAX VALUE ALONG Y-AXIS (DOUBLE PRECISION)
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       WRTBAD (VARNAM, ERFLAG)
C          WRITE NAMES OF ERRONEOUS VARIABLES
C       ERRMSG (MESSAG, FATAL)
C          PRINTS OUT A WARNING OR ERROR MESSAGE;  ABORT IF FATAL
C
C     COMMENTS
C       ASSUMES  X, Y, XMIN, XMAX, YMIN, YMAX ARE DOUBLE PRECISION
C       SETTING XMIN, XMAX, YMIN OR YMAX TO ZERO FORCES 'SEZMXY' TO FIND
C          THE CORRESPONDING VALUE DIRECTLY FROM THE 'X' OR 'Y' ARRAY
C       'NPTS' IS NOW AN ARRAY RATHER THAN A SCALAR
C       60-CHARACTER LABELS ARE NOW ALLOWED
C       IF FOR SOME REASON YOU WANT TO OMIT A POINT, SET EITHER ITS
C          X- OR Y-VALUE TO 1.E+36 (THE DO-NOT-PLOT-ME FLAG)
C
C     REFERENCES
C       KENNISON, D., 1985: AUTOGRAPH, THE UNABRIDGED WRITEUP, NCAR
C          TECH. NOTE TN-245, PP. 119-121.
C
```

```
      SUBROUTINE SEZMXY (LABG, LABX, LABY, X, Y, NPTS, MANY, IDXY, LTYP,
     1                   LROW, LBAC, NPAT, SYMBOL, XMIN, XMAX, YMIN,
     2                   YMAX)
C ---------------------------------------------------------------------
      CHARACTER*1       SYMBOL(*)
      CHARACTER*60      LABG, LABX, LABY
      INTEGER           IDXY, LTYP, LROW, LBAC, MANY, NPTS(*)
      DOUBLE PRECISION  X(IDXY,*), Y(IDXY,*), XMIN, XMAX, YMIN, YMAX
C ---------------------------------------------------------------------
      LOGICAL     INPERR, NEGAT
      INTEGER     DSHL(12), LLR
      PARAMETER   (MAXPT = 1000, MAXKRV = 10)
      DIMENSION   XX(MAXPT,MAXKRV), YY(MAXPT,MAXKRV)
      REAL        XXMIN, XXMAX, YYMIN, YYMAX, OMITIT
      DATA  DSHL / 65535, 21845, 63736, 60335, 58255, 45967,
     1             65535, 21845, 63736, 60335, 58255, 45967 /
      DATA  OMITIT / 1.E+36 /
C
C
C --------------- FOR GSFC ONLY;  STOPS SPLINING OF CURVES ----------
      CALL DASHSM (1)
C ---------------------------------------------------------------------
      INPERR = .FALSE.
      IF (LEN(LABG).GT.60)  CALL WRTBAD ('LABG', INPERR)
      IF (LEN(LABX).GT.60)  CALL WRTBAD ('LABX', INPERR)
      IF (LEN(LABY).GT.60)  CALL WRTBAD ('LABY', INPERR)
      IF (IDXY.LT.2)  CALL WRTBAD('IDXY', INPERR)
      IF ((MANY .LT. 1) .OR. (MANY .GT. 25))
     1   CALL WRTBAD ('MANY', INPERR)
      IF ((LTYP .LT. 0) .OR. (LTYP .GT. 4)) CALL WRTBAD ('LTYP', INPERR)
      IF ((LROW .LT. 1) .OR. (LROW .GT. 2)) CALL WRTBAD ('LROW', INPERR)
      IF ((LBAC .LT. 0) .OR. (LBAC .GT. 4)) CALL WRTBAD ('LBAC', INPERR)
      IF ((NPAT .EQ. 0) .OR. (NPAT .GT. 6)) CALL WRTBAD ('NPAT', INPERR)
      NPTMAX = 0
      DO 5  K = 1,MANY
         NPTMAX = MAX0 (NPTMAX, NPTS(K))
         IF (NPTS(K) .GT. IDXY) CALL WRTBAD ('NPTS', INPERR)
         IF ((NPTS(K) .LT. 2) .AND. (SYMBOL(K) .EQ. 'L'))
     1      CALL WRTBAD ('NPTS', INPERR)
         IF ((NPTS(K) .LT. 1) .AND. (SYMBOL(K) .NE. 'L'))
     1      CALL WRTBAD ('NPTS', INPERR)
    5    CONTINUE
C
      IF (INPERR) THEN
         WRITE (*,1000)  LABY, LABX, LABG
         CALL ERRMSG ('SEZMXY--INPUT PARAMETER(S) BAD', .FALSE.)
         END IF
      IF (NPTMAX .GT. MAXPT)
     1   CALL ERRMSG ('SEZMXY--INCREASE PARAMETER MAXPT', .TRUE.)
      IF (MANY .GT. MAXKRV)
     1   CALL ERRMSG ('SEZMXY--INCREASE PARAMETER MAXKRV', .TRUE.)
C
C       CONVERT PLOT ARRAYS TO SINGLE PRECISION
C
      DO 30 K = 1,MANY
         LLR = K
         IF(LROW .EQ. 1) LLR = 1
         DO 10 N = 1,NPTS(K)
```

```
          XX(N,K) = SNGL (X(N,LLR))
          YY(N,K) = SNGL (Y(N,K))
          IF (XX(N,K) .EQ. OMITIT) YY(N,K) = OMITIT
          IF (YY(N,K) .EQ. OMITIT) XX(N,K) = OMITIT
   10     CONTINUE
C
C       FILL REMAINDER OF PLOT ARRAYS WITH DON'T-PLOT-ME FLAGS
C
        DO 20 N = NPTS(K) + 1,NPTMAX
          XX(N,K) = OMITIT
          YY(N,K) = OMITIT
   20     CONTINUE
   30   CONTINUE
C
C       AVOID HAVING NEGATIVE VALUES BOMB LOG PLOTS
C
      IF ((LTYP .EQ. 3) .OR. (LTYP .EQ. 4))  THEN
        NEGAT = .FALSE.
        DO 40 K = 1,MANY
          DO 40 N = 1,NPTS(K)
            IF (XX(N,K) .LE. 0.0)  THEN
              NEGAT = .TRUE.
              XX(N,K) = OMITIT
              YY(N,K) = OMITIT
              END IF
   40       CONTINUE
        IF (NEGAT) THEN
          WRITE (*,1000)  LABY, LABX, LABG
          CALL ERRMSG ('SEZMXY--NEGATIVE X-VALUES OMITTED FROM PLOT.',
     1                 .FALSE.)
          END IF
        END IF
C
      IF ((LTYP .EQ. 2) .OR. (LTYP .EQ. 4))  THEN
        NEGAT = .FALSE.
        DO 50 K = 1,MANY
          DO 50 N = 1,NPTS(K)
            IF (YY(N,K) .LE. 0.0)  THEN
              NEGAT   = .TRUE.
              XX(N,K) = OMITIT
              YY(N,K) = OMITIT
              END IF
   50     CONTINUE
        IF (NEGAT) THEN
          WRITE (*,1000)  LABY, LABX, LABG
          CALL ERRMSG ('SEZMXY--NEGATIVE Y-VALUES OMITTED FROM PLOT.',
     1                 .FALSE.)
          END IF
        END IF
C
      CALL DISPLA (2, LROW, LTYP)
      IF (NPAT .GE. 1) CALL ANOTAT (LABX, LABY, LBAC, 0, 6, DSHL(NPAT))
      IF (NPAT .LT. 0) CALL ANOTAT (LABX, LABY, LBAC, 0, NPAT, '0')
C
C       CUT OFF CURVES OUTSIDE FRAME
C
      CALL AGSETF ('WINDOW.', 1.0)
C
```

```
C       MAKE CURVES GO RIGHT TO EDGE OF FRAME INSTEAD OF PICKING 'NICE'
C       MINIMUM AND MAXIMUM VALUES
C
      IF ((LTYP .EQ. 2) .OR. (LTYP .EQ. 4))
     1                       CALL AGSETF ('Y/NICE.', 0.0)
      IF ((LTYP .EQ. 3) .OR. (LTYP .EQ. 4))
     1                       CALL AGSETF ('X/NICE.', 0.0)
C
C       SET LOWER AND UPPER BOUNDS
C
      XXMIN =  1.0E+50
      XXMAX = -1.0E+50
      YYMIN =  1.0E+50
      YYMAX = -1.0E+50
      DO 60 K = 1,MANY
         DO 60 N = 1,NPTS(K)
            IF (XX(N,K) .NE. OMITIT)  THEN
               XXMIN = AMIN1(XXMIN,XX(N,K))
               XXMAX = AMAX1(XXMAX,XX(N,K))
               YYMIN = AMIN1(YYMIN,YY(N,K))
               YYMAX = AMAX1(YYMAX,YY(N,K))
               END IF
   60    CONTINUE
C
      IF (XMIN .NE. 0.0) XXMIN = SNGL(XMIN)
      IF (XMAX .NE. 0.0) XXMAX = SNGL(XMAX)
      IF (YMIN .NE. 0.0) YYMIN = SNGL(YMIN)
      IF (YMAX .NE. 0.0) YYMAX = SNGL(YMAX)
      IF (XMIN .EQ. 0.0) XMIN  = DBLE(XXMIN)
      IF (XMAX .EQ. 0.0) XMAX  = DBLE(XXMAX)
      IF (YMIN .EQ. 0.0) YMIN  = DBLE(YYMIN)
      IF (YMAX .EQ. 0.0) YMAX  = DBLE(YYMAX)
      IF (XXMIN .GE. XXMAX)  THEN
         WRITE (*,1000)  LABY, LABX, LABG
         CALL ERRMSG ('SEZMXY--MIN AND/OR MAX OF X-ARRAY BAD', .FALSE.)
         RETURN
         END IF
      IF (YYMIN .GE. YYMAX)  THEN
         WRITE (*,1000)  LABY, LABX, LABG
         CALL ERRMSG ('SEZMXY--MIN AND/OR MAX OF Y-ARRAY BAD', .FALSE.)
         RETURN
         END IF
      CALL AGSETF ('X/MIN.', XXMIN)
      CALL AGSETF ('X/MAX.', XXMAX)
      CALL AGSETF ('Y/MIN.', YYMIN)
      CALL AGSETF ('Y/MAX.', YYMAX)
C
C       MAKE TICK MARKS POINT IN
C
      CALL AGSETF ('LEFT/MAJOR/IN.', 0.015)
      CALL AGSETF ('RIGHT/MAJOR/IN.', 0.015)
      CALL AGSETF ('BOTTOM/MAJOR/IN.', 0.015)
      CALL AGSETF ('TOP/MAJOR/IN.', 0.015)
      CALL AGSETF ('LEFT/MAJOR/OUT.', 0.0)
      CALL AGSETF ('RIGHT/MAJOR/OUT.', 0.0)
      CALL AGSETF ('BOTTOM/MAJOR/OUT.', 0.0)
      CALL AGSETF ('TOP/MAJOR/OUT.', 0.0)
      CALL AGSETF ('LEFT/MINOR/IN.', 0.0075)
```

```
      CALL AGSETF ('RIGHT/MINOR/IN.', 0.0075)
      CALL AGSETF ('BOTTOM/MINOR/IN.', 0.0075)
      CALL AGSETF ('TOP/MINOR/IN.', 0.0075)
      CALL AGSETF ('LEFT/MINOR/OUT.', 0.0)
      CALL AGSETF ('RIGHT/MINOR/OUT.', 0.0)
      CALL AGSETF ('BOTTOM/MINOR/OUT.', 0.0)
      CALL AGSETF ('TOP/MINOR/OUT.', 0.0)
C
C       SET TOP LABEL
C
      CALL AGSETF ('LINE/MAXIMUM.', 60.0)
      CALL AGSETF ('LABEL/NAME.', 'T')
      CALL AGSETI ('LINE/NUMBER.', +100)
      CALL AGSETF ('LINE/CHARACTER.', 0.015)
      CALL AGSETP ('LINE/TEXT.', LABG, LEN(LABG))
C
C       DO SETUP TASKS
C
      CALL AGSTUP (XX, MANY, IDXY, NPTMAX, 1, YY, MANY, IDXY, NPTMAX, 1)
C
C       DRAW BACKGROUND
C
      CALL AGBACK
      IDSH = NPAT
      INC = 1
      IF (NPAT .LT. 0)  INC = - 1
      DO 100 K = 1,MANY
         IF(SYMBOL(K) .EQ. 'L') THEN
            CALL AGCURV (XX(1,K), 1, YY(1,K), 1, NPTS(K), IDSH)
            IDSH = IDSH + INC
            ELSE IF (SYMBOL(K) .EQ. '.') THEN
               CALL POINTS (XX(1,K), YY(1,K), NPTS(K), 0, 0)
               ELSE
                  CALL POINTS (XX(1,K), YY(1,K), NPTS(K), SYMBOL(K), 0)
                  END IF
  100    CONTINUE
      CALL FRAME
C
C          RESTORE SOME DEFAULTS
C
      CALL AGSETF ('Y/NICE.', -1.0)
      CALL AGSETF ('X/NICE.', -1.0)
      CALL AGSETF ('Y/MIN.', OMITIT)
      CALL AGSETF ('Y/MAX.', OMITIT)
      CALL AGSETF ('X/MIN.', OMITIT)
      CALL AGSETF ('X/MAX.', OMITIT)
      RETURN
 1000 FORMAT( /,' ERROR IN PLOTTING ', A, /, 16X, 'VS ', A, /,
     1          '     GRAPH LABEL = ', A, / )
      END
C     SUBROUTINE WRTBAD
C
C     PURPOSE
C       WRITE NAMES OF ERRONEOUS VARIABLES
C
C     USAGE
C       CALL WRTBAD (VARNAM, ERFLAG)
C
```

```
C     DESCRIPTION OF PARAMETERS
C       VARNAM - NAME OF ERRONEOUS VARIABLE TO BE WRITTEN (CHARACTER,
C                ANY LENGTH)
C       ERFLAG - LOGICAL FLAG, SET TRUE BY THIS ROUTINE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
C
      SUBROUTINE WRTBAD (VARNAM, ERFLAG)
C ---------------------------------------------------------------------
      CHARACTER*(*)  VARNAM
      LOGICAL        ERFLAG
      INTEGER        MAXMSG, NUMMSG
      SAVE           NUMMSG, MAXMSG
      DATA  NUMMSG / 0 /,  MAXMSG / 50 /
C
C
      NUMMSG = NUMMSG + 1
      WRITE (*,'(3A)')  ' ****  INPUT VARIABLE  ', VARNAM,
     1                  '  IN ERROR  ****'
      ERFLAG = .TRUE.
      IF (NUMMSG .EQ. MAXMSG)
     1   CALL ERRMSG ('TOO MANY INPUT ERRORS.  ABORTING...$', .TRUE.)
      RETURN
      END
C     SUBROUTINE ERRMSG
C
C     PURPOSE
C       PRINTS OUT A WARNING OR ERROR MESSAGE;  ABORT IF FATAL
C
C     USAGE
C       CALL ERRMSG (MESSAG, FATAL)
C
C     DESCRIPTION OF PARAMETERS
C       MESSAG - WARNING OR ERROR MESSAGE TO BE PRINTED
C       FATAL  - LOGICAL FLAG
C                .TRUE.  FATAL ERROR, WRITE MESSAGE AND STOP PROCESSING
C                .FALSE. WRITE ERROR MESSAGE AND CONTINUE PROCESSING
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
C
      SUBROUTINE ERRMSG (MESSAG, FATAL)
C ---------------------------------------------------------------------
      CHARACTER*(*)  MESSAG
      LOGICAL        FATAL, ONCE
      INTEGER        MAXMSG, NUMMSG
      SAVE           MAXMSG, NUMMSG, ONCE
      DATA  NUMMSG / 0 /,  MAXMSG / 100 /,  ONCE / .FALSE. /
C
C
      IF (FATAL)  THEN
         WRITE (*,'(2A)') ' ******* ERROR >>>>>>  ', MESSAG
         STOP
         END IF
C
      NUMMSG = NUMMSG + 1
      IF (NUMMSG .GT. MAXMSG)  THEN
```

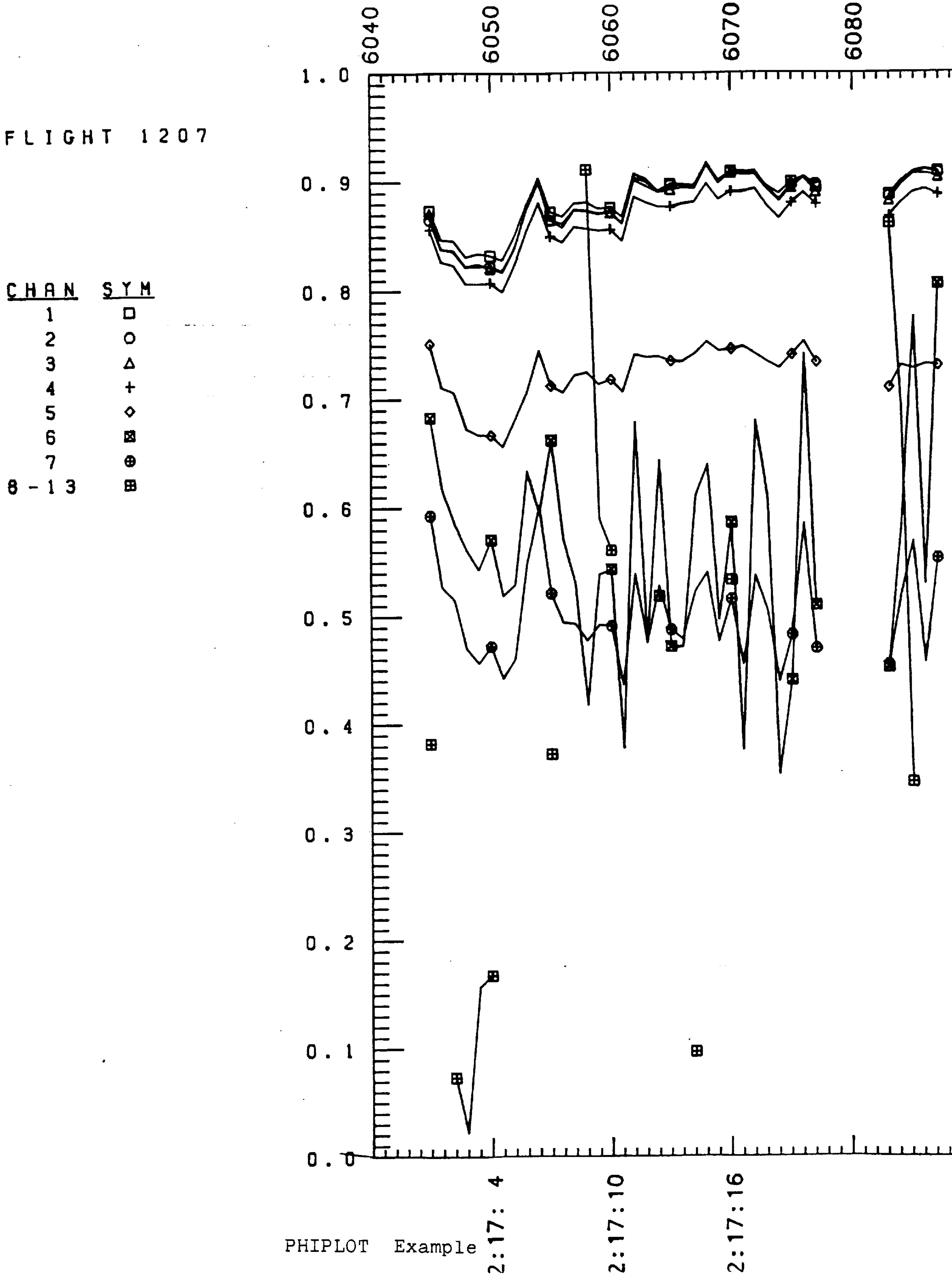
```
         IF (.NOT. ONCE)  WRITE (*,1000)
         ONCE = .TRUE.
         ELSE
            WRITE ( *, '(2A)' ) ' ******* WARNING >>>>>>   ', MESSAG
            END IF
      RETURN
 1000 FORMAT(///,' >>>>>>  TOO MANY WARNING MESSAGES --  ',
     1        'THEY WILL NO LONGER BE PRINTED  <<<<<<', /// )
      END
```

# Appendix B

# PHIPLOT

PHIPLOT Plot Example

Program Listing




PHIPLOT Example

```
C       PROGRAM PHIPLOT - 05/16/88
C
C       PURPOSE
C         PLOT THE PHI DATA FROM THE CLOUD ABSORPTION RADIOMETER
C
C       DESCRIPTION OF PARAMETERS
C         MODE    - VARIABLE FOR USE BY CARNALYS
C         WVL     - ARRAY OF WAVELENGTHS IN MICRONS
C         CALSLP  - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2*MICRON*SR*V)
C         CALINT  - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2*MICRON*SR)
C         AGO     - ARRAY OF GROUND ALBEDOS(WAVELENGTH)
C         SIGAG   - ARRAY OF GROUND ALBEDO STANDARD DEVIATIONS (WAVELENGTH)
C         PRTPLT  - PRINTER PLOTS                          (.NE. 0 = YES)
C         ZTAPLT  - ZETA PLOTS       (TEMPLATE TO ZETA) (.NE. 0 = YES)
C         HRDPLT  - HARD COPY PLOTS (TEMPLATE TO 3800) (.NE. 0 = YES)
C         NSCALE  - PLOT SCALING, NUMBER OF SCANS AVERAGED/PLOTTED VALUE
C                   0,1 - ALL SCANS PLOTTED (NO COMPRESSION) (6 SEC/IN)
C                    2  - 2 SCANS AVERAGED (12 SEC/IN)
C                    .    .
C                    .    .
C                    .    .
C                    20 - 20 SCANS AVERAGED (120 SEC/IN)
C         ISCAN1 - ARRAY OF FIRST SCAN LINES TO BE PROCESSED
C                    IF ISCAN1 .EQ. 0, START AT BEGINNING OF FILE
C         ISCAN2 - ARRAY OF LAST SCAN LINES TO BE PROCESSED
C                    IF ISCAN2 .EQ. 0, END AT EOF
C
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C         READ5
C            READ AND LIST DATA CARDS AND REWIND INPUT LOGICAL UNIT 5
C         CARDAT (ISCAN1, ISCAN2, WVL, CALSLP, CALINT,
C                 NFLT, NSCAN, KSCAN, ITIME, PHI, ICH8, NPASS)
C            READ AIRCRAFT DATA FOR SCAN LINES BETWEEN ISCAN1 AND ISCAN2
C         PRINTR (WVL, CALSLP, CALINT,
C                 NFLT, NSCAN, KSCAN, ITIME, PHI, ICH8)
C            CREATE PRINTER PLOT OF PHI DATA
C         ZETA (NSCALE, WVL, CALSLP, CALINT, INDEX, NPASS,
C               NFLT, NSCAN, KSCAN, ITIME, PHI, ICH8)
C            CREATE ZETA PLOT OF PHI DATA
C
C       DESCRIPTION OF INPUT DATA DECK
C         MODE
C         WVL(1)       . . .    WVL(13)
C         CALSLP(1)    . . .    CALSLP(13)
C         CALINT(1)    . . .    CALINT(13)
C         AGO(1)       . . .    AGO(13)
C         SIGAG(1)     . . .    SIGAG(13)
C         PRTPLT      ZTAPLT    HRDPLT     NSCALE
C         ISCAN1(1)  ISCAN2(1)
C            .          .
C            .          .
C            .          .
C         ISCAN1(N)  ISCAN2(N)
C
C       COMMENTS
C         PROGRAM IS MOSTLY DOUBLE PRECISION (EXCEPT PLOT VARIABLES)
C         ARRAYS ARE DIMENSIONED FOR UP TO 20000 SCAN LINES
```

```
C       ARRAYS ARE DIMENSIONED FOR UP TO   13 WAVELENGTHS
C
C     REFERENCES
C       KING, M. D., 1981:  J. ATMOS. SCI., 38, 2031-2044.
C
C     MODIFICATIONS
C       04/13/88 - ADD VARIABLE PLOT SCALES (SECS/IN).  LIMIT LENGTH
C                  OF PLOTS TO 30 INCHES (36 INCHES WITH END LABELS)
C                  ONLY WITH ISCAN1 AND ISCAN2
C       05/16/88 - MAKE ROLL AND GAIN CALCULATIONS COMPATIBLE WITH
C                  CARANLYS
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL      PHI(20000,8)
      DIMENSION ICH8(20000),KSCAN(20000)
      DIMENSION AGO(13),SIGAG(13),WVL(13),CALSLP(13),CALINT(13)
      DIMENSION ISCAN1(50),ISCAN2(50),NSCAN(50)
      INTEGER*2 ITIME(20000,3)
      IPLOT = 0
      CALL READ5
      READ(5,1000) MODE
      READ(5,1010) (WVL(I),I=1,13)
      READ(5,1010) (CALSLP(I),I=1,13)
      READ(5,1010) (CALINT(I),I=1,13)
      READ(5,1010) (AGO(I),I=1,13)
      READ(5,1010) (SIGAG(I),I=1,13)
      READ(5,1000) PRTPLT,ZTAPLT,HRDPLT,NSCALE
      CALL CARDAT(ISCAN1,ISCAN2,WVL,CALSLP,CALINT,
     1            NFLT,NSCAN,KSCAN,ITIME,PHI,ICH8,NPASS)
C
C       PRODUCE PRINTER PLOTS IF DESIRED
C
      IF (PRTPLT .NE. 0) THEN
         DO 20 I = 1,NPASS
            ISCEND = 0
            DO 10 II = 1,I
               ISCEND = ISCEND + NSCAN(II)
   10          CONTINUE
            ISCSTR = ISCEND - NSCAN(I) + 1
            NSCAN1 = NSCAN(I)
            CALL PRINTR(WVL,CALSLP,CALINT,ISCSTR,ISCEND,
     1                  NFLT,NSCAN1,KSCAN,ITIME,PHI,ICH8)
   20       CONTINUE
         END IF
C
C       PRODUCE ZETA PLOTS IF DESIRED
C
      IF (ZTAPLT .NE. 0) THEN
         DO 30 I = 1,NPASS
            INDEX = I
            CALL ZETA(NSCALE,WVL,CALSLP,CALINT,INDEX,NPASS,
     1                NFLT,NSCAN,KSCAN,ITIME,PHI,ICH8)
   30       CONTINUE
         END IF
  999 STOP
 1000 FORMAT(7I10)
 1010 FORMAT(7D10.0)
      END
```

```
C       SUBROUTINE READ5
C
C       PURPOSE
C         READ AND WRITE INPUT DATA CARDS FROM LOGICAL UNIT 5
C
C       USAGE
C         CALL READ5
C
C       DESCRIPTION OF PARAMETERS
C         NONE
C
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C         NONE
C
C       COMMENTS
C         SUBROUTINE REWINDS LOGICAL UNIT 5 SO THE INPUT IS READY TO BE
C         READ BY THE PROGRAM
C
      SUBROUTINE READ5
      DIMENSION CARD(18)
      WRITE(6,1000)
   10 READ(5,1010,END=999) CARD
      WRITE(6,1020) CARD
      GO TO 10
  999 CONTINUE
      REWIND 5
      RETURN
 1000 FORMAT(1H1,//,10X,'THE CONTENTS OF THE INPUT FILE ON UNIT 5 ARE:',
     1       //)
 1010 FORMAT(18A4)
 1020 FORMAT(10X,18A4)
      END
C       SUBROUTINE CARDAT
C
C       PURPOSE
C         READ AIRCRAFT DATA FOR SCAN LINES BETWEEN ISCAN1 AND ISCAN2
C
C       USAGE
C         SUBROUTINE CARDAT (ISCAN1, ISCAN2, WVL, CALSLP, CALINT,
C                            NFLT, NSCAN, KSCAN, ITIME, PHI, ICH8, NPASS)
C
C       DESCRIPTION OF PARAMETERS
C         ISCAN1 - ARRAY OF FIRST SCAN LINES TO BE PROCESSED
C         ISCAN2 - ARRAY OF LAST SCAN LINES TO BE PROCESSED
C         WVL    - ARRAY OF WAVELENGTHS IN MICRONS
C         CALSLP - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2*MICRON*SR*V)
C         CALINT - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2*MICRON*SR)
C         NFLT   - FLIGHT NUMBER
C         NSCAN  - ARRAY OF NUMBERS OF SCAN LINES PROCESSED
C         KSCAN  - ARRAY OF SCAN LINE NUMBERS PROCESSED
C         ITIME  - ARRAY OF TIMES OF PROCESSED SCAN LINES
C         PHI    - ARRAY OF RATIO OF INTENSITIES AT THETA = 180 DEGREES
C                       DIVIDED BY THE INTENSITIES AT THETA = 0 DEGREES
C         ICH8   - ARRAY OF FILTER POSITION FOR EACH SCAN LINE
C         NPASS  - NUMBER OF SCAN LINE PAIRS PROCESSED
C
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C         NONE
```

```
C
C     DESCRIPTION OF INPUT DATA DECK
C       SEE MAIN
C
C     COMMENTS
C       SUBROUTINE IS MOSTLY DOUBLE PRECISION (EXCEPT PLOT VARIABLES)
C       ARRAYS ARE DIMENSIONED FOR UP TO 20000 SCAN LINES
C       THIS VERSION OF CARDAT IS NOW MARKEDLY DIFFERENT FROM THE
C       CARANLYS VERSION, BUT THE COMPUTATIONAL PARTS ARE THE SAME
C
C     REFERENCES
C       NONE
C
      SUBROUTINE CARDAT(ISCAN1,ISCAN2,WVL,CALSLP,CALINT,
     1                  NFLT,NSCAN,KSCAN,ITIME,PHI,ICH8,NPASS)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      DOUBLE PRECISION INTEN(2,8)
      REAL         PHI(20000,8),SLOPE,YINTCP
      DIMENSION    KSCAN(20000),ICH8(20000)
      DIMENSION    LCOUNT(435,8),VOLT(435,8),THETA(435),AMU(435)
      DIMENSION    WVL(13),CALSLP(13),CALINT(13)
      DIMENSION    NSCAN(1),ISCAN1(1),ISCAN2(1)
      INTEGER*2    IDATA(3505),ITIME(20000,3)
      CHARACTER*9 CHRPHI(6),BLANK,CPHI
      EQUIVALENCE (IDATA(11),SLOPE),(IDATA(13),YINTCP)
      FACTR  = 180.0D0/(2**11)
      SIGN   = 1.0
      PI     = DARCOS(-1.0D0)
      DEGRAD = PI / 180.0D0
      READ(5,1000) ISCAN1(1),ISCAN2(1)
      DO 5 I = 1,50
         NSCAN(I)  = 0
    5    CONTINUE
      NSCN   = 0
      NPASS  = 1
C
C       READ DATA FOR SINGLE SCAN LINE FROM AIRCRAFT TAPE
C
   10 READ(10,1010,END=90) IDATA
         LSCAN  = IDATA(5)
         IF (LSCAN .LT. ISCAN1(NPASS)) GO TO 10
         IF (ISCAN1(NPASS) .EQ. 0) ISCAN1(NPASS) = LSCAN
         IF ((LSCAN .GT. ISCAN2(NPASS)) .AND.
     1              (ISCAN2(NPASS) .NE. 0)) GO TO 80
         NFLT   = IDATA(10)
         NANGS  = IDATA(20)
         DT     = 190.0D0 / (NANGS-1)
         DO 20 I = 1,NANGS
            THETA(I) = (I-1)*DT - 5.0D0
   20       CONTINUE
         IF (IDATA(9) .LT. 128) AROLL = IDATA(9)*FACTR
         IF (IDATA(9) .GE. 128) AROLL = (IDATA(9)-256)*FACTR
         IF (NFLT .GE. 1139) AROLL = 4.0D0*AROLL
         IF ((AROLL .LT. -4.5D0) .OR. (AROLL .GT. 5.0D0)) THEN
            IF (LSCAN .EQ. ISCAN2(NPASS)) GO TO 80
            GO TO 10
            END IF
C
```

```
C          CHANGE THE SIGN OF THE ROLL FOR THE CONVAIR-131A AIRCRAFT
C
        IF (NFLT .GE. 1160) AROLL = -AROLL
        IF ((IDATA(19) .GE. 0) .AND. (IDATA(19) .LE. 2)) THEN
           IF (IDATA(19) .EQ. 0) GAIN = 0.5D0
           IF (IDATA(19) .EQ. 1) GAIN = 1.0D0
           IF (IDATA(19) .EQ. 2) GAIN = 2.0D0
           ELSE
              IF (LSCAN .EQ. ISCAN2(NPASS)) GO TO 80
              GO TO 10
              END IF
        NSCAN(NPASS)  = NSCAN(NPASS) + 1
        NSCN          = NSCN         + 1
        IF (NSCN .GT. 20000) GO TO 90
        KSCAN(NSCN)   = IDATA(5)
        ITIME(NSCN,1) = IDATA(2)
        ITIME(NSCN,2) = IDATA(3)
        ITIME(NSCN,3) = IDATA(4)
        ICH8(NSCN)    = IDATA(6) + 7
C
C          CONVERT COUNTS TO VOLTAGE
C
        DO 40 N = 1,NANGS
           IOFF = 23 + 8*(N-1)
           DO 30 I = 1,8
              INP          = IOFF + I
              LCOUNT(N,I) = IDATA(INP)
              VOLT(N,I)    = (LCOUNT(N,I) - YINTCP)/SLOPE
   30         CONTINUE
   40      CONTINUE
C
C          LOCATE PIXELS AT THE ZENITH AND NADIR DIRECTIONS
C
        IF (NFLT .LT. 1160) SIGN = -1.0
        EPS1   = 0.1D0
        EPS2   = 0.1D0
        DO 60 N = 1,NANGS
           ANGLE  = (THETA(N) + SIGN*AROLL)*DEGRAD
           AMU(N) = DCOS(ANGLE)
           DIFF   = DABS(AMU(N) - 1.0D0)
           IF (DIFF .GT. EPS1) GO TO 50
           EPS1   = DIFF
           I0     = N
   50      DIFF   = DABS(AMU(N) + 1.0D0)
           IF (DIFF .GT. EPS2) GO TO 60
           EPS2   = DIFF
           I180   = N
   60      CONTINUE
C
C            CONVERT VOLTAGE TO INTENSITY AND CREATE PHI ARRAY
C
        DO 70 K = 1,8
           KK          = K
           IF (K  .EQ. 8) KK = ICH8(NSCN)
           IF ((K .EQ. 8) .AND. (KK .EQ. 7)) GO TO 70
           INTEN(1,K)  = (VOLT(I0,K)*CALSLP(KK) + CALINT(KK)) / GAIN
           INTEN(2,K)  = (VOLT(I180,K)*CALSLP(KK) + CALINT(KK)) / GAIN
           PHI(NSCN,K) = INTEN(2,K) / INTEN(1,K)
```

```
   70        CONTINUE
      IF (LSCAN .EQ. ISCAN2(NPASS)) GO TO 80
      GO TO 10
   80 IF ((NPASS+1) .GT. 50) GO TO 90
      READ(5,1000,END=90) ISCAN1(NPASS+1),ISCAN2(NPASS+1)
      NPASS = NPASS + 1
      GO TO 10
C
C       WRITE OUT PHI TABLE
C
   90 DO 110 I = 1,NSCN
         DO 100 J = 1,6
            CHRPHI(J) = BLANK
  100       CONTINUE
         IF (PHI(I,8) .NE. 0.0D0) THEN
            WRITE(CPHI,1020) PHI(I,8)
            ICHN = ICH8(I) - 7
            CHRPHI(ICHN) = CPHI
            END IF
         IM1 = I - 1
         IF (MOD(IM1,56) .EQ. 0) WRITE(6,1030) (K,K=1,13)
         WRITE(6,1040) KSCAN(I),(PHI(I,J),J=1,7),(CHRPHI(J),J=1,6)
  110    CONTINUE
      RETURN
 1000 FORMAT(7I10)
 1010 FORMAT(71(80A2))
 1020 FORMAT(F9.5)
 1030 FORMAT(1H1,/,
     1       6H  SCAN,13(2X,4HPHI(,I2,1H)),/,1X,5(1H-),13(2X,7(1H-)))
 1040 FORMAT(I6,7F9.5,6A9)
      END
C     SUBROUTINE PRINTR
C
C     PURPOSE
C       CREATE PRINTER PLOT OF PHI DATA
C
C     USAGE
C       SUBROUTINE PRINTR (WVL, CALSLP, CALINT,ISCSTR,ISCEND,
C                         NFLT, NSCAN, KSCAN, ITIME, PHI, ICH8)
C
C     DESCRIPTION OF PARAMETERS
C       WVL    - ARRAY OF WAVELENGTHS IN MICRONS
C       CALSLP - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2*MICRON*SR*V)
C       CALINT - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2*MICRON*SR)
C       ISCSTR - START INDEX IN ARRAYS FOR THIS CALL
C       ISCEND - END INDEX IN ARRAYS FOR THIS CALL
C       NFLT   - FLIGHT NUMBER
C       NSCAN  - NUMBER OF SCAN LINES PROCESSED
C       KSCAN  - ARRAY OF SCAN LINE NUMBERS PROCESSED
C       ITIME  - ARRAY OF TIMES OF PROCESSED SCAN LINES
C       PHI    - ARRAY OF RATIO OF INTENSITIES AT THETA = 180 DEGREES
C                    DIVIDED BY THE INTENSITIES AT THETA = 0 DEGREES
C       ICH8   - ARRAY OF FILTER POSITION FOR EACH SCAN LINE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       NONE
C
C     DESCRIPTION OF INPUT DATA DECK
```

```
C        NONE
C
C     COMMENTS
C       SUBROUTINE IS SINGLE PRECISION (EXECPT NON-PLOT VARIABLES)
C       ARRAYS ARE DIMENSIONED FOR UP TO 20000 SCAN LINES
C       PLOT CHARACTER CORRESPONDENCE TO CHANNEL NUMBER:
C         CHANNEL   CHARACTER
C            1          *
C            2          +
C            3          #
C            4          ,
C            5          .
C            6          $
C            7          @
C          8-13         &
C
C     REFERENCES
C       NONE
C
      SUBROUTINE PRINTR(WVL,CALSLP,CALINT,ISCSTR,ISCEND,
     1                  NFLT,NSCAN,KSCAN,ITIME,PHI,ICH8)
      DOUBLE PRECISION WVL(1),CALSLP(1),CALINT(1)
      DIMENSION   PHI(20000,8),KSCAN(1),ICH8(1),TENTHS(11)
      INTEGER*2   ITIME(20000,3)
      CHARACTER*1 LINE(119),BLNKLN(119),CHAR(8),BLANK1,VERT
      DATA        CHAR/'*','+','#',',','.','$','@','&'/
      DATA        BLANK1/' '/,VERT/'|'/
      DATA        BLNKLN/'|',8*' ','|',99*' ','|',8*' ','|'/
      DATA        TENTHS/0.0,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0/
      WRITE(6,1000) NFLT,KSCAN(ISCSTR),KSCAN(ISCEND),
     1              (ITIME(ISCSTR,I),I=1,3),(ITIME(ISCEND,I),I=1,3),
     2              (I,WVL(I),CALSLP(I),CALINT(I),I=1,13)
      N   = ISCSTR - 1
      NSC = KSCAN(ISCSTR)
C
C       START A NEW PAGE
C
   10 WRITE(6,1010) (I,CHAR(I),I=1,7),(I,I=8,13,5),CHAR(8)
      WRITE(6,1020) (TENTHS(I),I=1,11)
      WRITE(6,1030)
      II = 0
      IE = 0
   20   II  = II  + 1
        IE  = IE  + 1
        N   = N   + 1
        NSC = NSC + 1
        DO 30 ICOL = 1,119
          LINE(ICOL) = BLNKLN(ICOL)
   30     CONTINUE
        DO 40 J = 1,8
          IF (PHI(N,J) .LT. 0.0) THEN
            LINE(J+1)   = CHAR(J)
            GO TO 40
            END IF
          IF (PHI(N,J) .GT. 1.0) THEN
            LINE(J+107) = CHAR(J)
            GO TO 40
            END IF
```

```
            IF ((J .EQ. 8) .AND. (PHI(N,J) .EQ. 0.0)) GO TO 40
            IPHI = PHI(N,J) * 100.0
            ICOL = 10 + IPHI
            IF (ICOL .EQ. 100) ICOL = 99
            LINE(ICOL) = CHAR(J)
  40        CONTINUE
         IF ((IE .EQ. 1) .OR. (MOD(IE,10) .EQ. 0)) THEN
            LINE(1)   = CHAR(2)
            LINE(10)  = CHAR(2)
            LINE(110) = CHAR(2)
            LINE(119) = CHAR(2)
            END IF
         WRITE(6,1040) (LINE(ICOL),ICOL=1,119)
         IF ((IE .EQ. 1) .OR. (MOD(IE,10) .EQ. 0))
     1        WRITE(6,1050) (ITIME(N,IT),IT= 1,3),KSCAN(N)
         IF (NSC .EQ. KSCAN(N)) GO TO 70
  50     IF (NSC .NE. KSCAN(N+1)) THEN
            II  = II  + 1
            IF (II .LE. 50) WRITE(6,1040) (BLNKLN(ICOL),ICOL=1,119)
            NSC = NSC + 1
            IF (NSC .GT. KSCAN(ISCEND)) GO TO 70
            IF (NSC .EQ. KSCAN(N)) GO TO 70
            IE  = 0
            GO TO 50
            END IF
         IF (II .LT. 50) GO TO 20
      WRITE(6,1030)
      WRITE(6,1020) (TENTHS(I),I=1,11)
      GO TO 10
  70  WRITE(6,1030)
      WRITE(6,1020) (TENTHS(I),I=1,11)
      RETURN
 1000 FORMAT(1H1,/,
     1       37H THE FOLLOWING PHI PLOT DATA ARE FOR:,/,
     2       15H-FLIGHT NUMBER:,I5,//,
     3       19H START SCAN NUMBER:,I6,5X,16HEND SCAN NUMBER:,I6,//,
     4       12H START TIME:,I7,1H:,I2,1H:,I2,4X,
     5       10H END TIME:,I7,1H:,I2,1H:,I2,/////,
     6       38H THE CHANNEL DEPENDENT PARAMETERS ARE:,///,
     7       11X,10HWAVELENGHT,4X,17HCALIBRATION SLOPE,5X,
     8       21HCALIBRATION INTERCEPT,/,8H CHANNEL,5X,7HMICRONS,4X,
     9       20HMW/CM**2-MICRON-SR-V,4X,18HMW/CM**2-MICRON-SR,/,
     A        1X,7(1H-),3X,10(1H-),3X,20(1H-),3X,21(1H-),/,
     B       (I6,F13.4,F18.4,F23.3))
 1010 FORMAT(1H1,/,9X,
     1        8HCHANNEL:,7(1X,I1,2H=>,A1,1H,),1X,I1,1H-,I2,2H=>,A1,///,
     2       67X,3HPHI,/)
 1020 FORMAT(10X,11(7X,F3.1))
 1030 FORMAT(9X,1H+,8(1H-),1H+,10(9(1H-),1H+),8(1H-),1H+)
 1040 FORMAT(9X,119A1)
 1050 FORMAT(1H+,I2,2(1H:,I2),119X,I5)
      END
C     SUBROUTINE ZETA
C
C     PURPOSE
C       CREATE ZETA PLOT OF PHI DATA
C
C     USAGE
```

```
C       SUBROUTINE ZETA (NSCALE, WVL, CALSLP, CALINT, INDEX, NPASS,
C                        NFLT, NSCAN, KSCAN, ITIME, PHI, ICH8)
C
C     DESCRIPTION OF PARAMETERS
C       NSCALE - PLOT SCALING, NUMBER OF SCANS AVERAGED/PLOTTED VALUE
C                0,1 - ALL SCANS PLOTTED (NO COMPRESSION) (6 SEC/IN)
C                 2  - 2 SCANS AVERAGED (12 SEC/IN)
C                 .    .
C                 .    .
C                 .    .
C                 20 - 20 SCANS AVERAGED (120 SEC/IN)
C       WVL    - ARRAY OF WAVELENGTHS IN MICRONS
C       CALSLP - ARRAY OF CALIBRATION SLOPES IN MW/(CM**2*MICRON*SR*V)
C       CALINT - ARRAY OF CALIBRATION INTERCEPTS IN MW/(CM**2*MICRON*SR)
C       INDEX  - INDEX OF THIS CALL TO ZETA
C       NPASS  - TOTAL NUMBER OF CALLS TO ZETA
C       NFLT   - FLIGHT NUMBER
C       NSCAN  - NUMBER OF SCAN LINES PROCESSED
C       KSCAN  - ARRAY OF SCAN LINE NUMBERS PROCESSED
C       ITIME  - ARRAY OF TIMES OF PROCESSED SCAN LINES
C       PHI    - ARRAY OF RATIO OF INTENSITIES AT THETA = 180 DEGREES
C                   DIVIDED BY THE INTENSITIES AT THETA = 0 DEGREES
C       ICH8   - ARRAY OF FILTER POSITION FOR EACH SCAN LINE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C       TEMPLATE PLOT PACKAGE
C
C     DESCRIPTION OF INPUT DATA DECK
C       NONE
C
C     COMMENTS
C       SUBROUTINE IS SINGLE PRECISION (EXECPT NON-PLOT VARIABLES)
C       ARRAYS ARE DIMENSIONED FOR UP TO 20000 SCAN LINES
C
C       PLOT CHARACTER CORRESPONDENCE TO CHANNEL NUMBER:
C         CHANNEL      CHARACTER       TEMPLATE CODE
C
C         -------    -------------    ------------
C            1         SQUARE              1.0
C            2         CIRCLE              2.0
C            3         TRIANGLE            3.0
C            4         PLUS                4.0
C            5         DIAMOND             5.0
C            6         SQUARE/DIAMOND      6.0
C            7         CIRCLE/PLUS         8.0
C          8-13        SQUARE/PLUS         9.0
C
C     REFERENCES
C       NONE
C
      SUBROUTINE ZETA(NSCALE,WVL,CALSLP,CALINT,INDEX,NPASS,
     1                NFLT,NSCAN,KSCAN,ITIME,PHI,ICH8)
      DOUBLE PRECISION WVL(1),CALSLP(1),CALINT(1)
      DIMENSION   PHI(20000,8),KSCAN(1),ICH8(1),NSCAN(1)
      CHARACTER*5 CHAN(8),CFLT
      CHARACTER*4 TENTHS(11)
      CHARACTER*3 CHR,CMN,CSC
      CHARACTER*2 CLN,CIS
      INTEGER*2   ITIME(20000,3)
```

```
      DATA        CHAN   /'  1 $',' 2 $',' 3 $',' 4 $',
     1                  ' 5 $',' 6 $',' 7 $','8-13$'/
      DATA        TENTHS/'0.0$','0.1$','0.2$','0.3$','0.4$','0.5$',
     1                  '0.6$','0.7$','0.8$','0.9$','1.0$'/
      DATA        CLN    /':$'/
      IF (INDEX .EQ. 1) THEN
         CALL UCONFG(51.0)
         CALL USTART
         CALL UPSET('FNTF',11.0)
         CALL UFONT('SROM')
         END IF
C
C       DEFINE STARTING AND ENDING ARRAY INDICIES FOR THIS PASS
C
      ISCEND = 0
      DO 5 I = 1,INDEX
         ISCEND = ISCEND + NSCAN(I)
    5    CONTINUE
      ISCSTR = ISCEND - NSCAN(INDEX) + 1
C
C       SEARCH FOR END OF MONOTONICALLY INCREASING SCAN LINE NUMBER
C
      NSCN   = ISCSTR
      ISTRP1 = ISCSTR + 1
      DO 10 NS = ISTRP1,ISCEND
         IF (KSCAN(NS) .LE. KSCAN(NS-1)) GO TO 20
         NSCN = NS
   10    CONTINUE
C
C       CALCULATE LENGTH OF PLOT (10*NSCALE SCAN LINES/INCH), ADJUST THE
C       VIRTUAL-SPACE WINDOW ACCORDINGLY, AND DRAW AND LABEL THE AXES
C
C       THE NEGATIVE VALUES FOR THE STARTING POINTS OF THE WINDOW LEAVE
C       A BORDER AROUND THE AXES FOR LABELING AND CAUSE THE ORIGN OF
C       THE AXES TO BE AT (0.0,0.0).  THE X-AXIS IS IN 'INCHES', THE
C       Y-AXIS ALLOWS FOR VALUES 0.0-1.0.
C
   20 NSCNPI = 10 * NSCALE
      SCNNPI = NSCNPI
      IREM1  = MOD(KSCAN(ISCSTR),NSCNPI)
      IREM2  = NSCNPI - MOD(KSCAN(NSCN),NSCNPI)
      XLNGTH = (KSCAN(NSCN) - KSCAN(ISCSTR) + IREM1 + IREM2)/SCNNPI
      IF (XLNGTH .LE. 0.0) GO TO 900
      NSTART = KSCAN(ISCSTR) - IREM1
      RKSCAN = NSTART
      YLNGTH = 9.0
      YSIZE  = 11.0
      XBMRGN = ((YSIZE - YLNGTH)/YLNGTH)*0.6250
      XTMRGN = 1.0 + XBMRGN*0.60
      YLMRGN = 3.0
      YRMRGN = 3.0
      ENDPLT = XLNGTH + YRMRGN
      XPLT   = ENDPLT + YLMRGN
      CALL UDIMEN(XPLT,YSIZE)
      CALL UWINDO(-YLMRGN,ENDPLT,-XBMRGN,XTMRGN)
      XPLT1  = XPLT  - 0.001
      YSIZE1 = YSIZE - 0.001
      CALL UVWPRT(0.0,XPLT1,0.0,YSIZE1)
```

```
      CALL UMOVE(0.0,0.0)
      CALL UDRAW(XLNGTH,0.0)
      CALL UDRAW(XLNGTH,1.0)
      CALL UDRAW(0.0,1.0)
      CALL UDRAW(0.0,0.0)
C
C       TICK MARKS, NUMERIC AXES LABELS, AND CHANNEL/SYMBOL TABLES
C
      XTMLN1 = 0.1500 / YLNGTH
      XTMLN2 = 0.4000 * XTMLN1
      YTMLN1 = 0.2500
      YTMLN2 = YTMLN1 / 2.0
      XNUMDX = 0.0750
      XNUMDY = 0.1250 / YSIZE
      YNUMDX = 0.5500
      YNUMDY = 0.0625 / YSIZE
      CALL USET('MEDI')
C
C          CHANNEL/SYMBOL TABLE, LEFT
C
      XPOS   = -YLMRGN
      YPOS   =  0.94
      CALL UMOVE(XPOS,YPOS)
      CALL UPRNT1('FLIGHT $','TEXT')
      WRITE(CFLT,1000) NFLT
      CALL UPRNT1(CFLT,'TEXT')
      YPOS   =  0.8
      CALL UMOVE(XPOS,YPOS)
      CALL USET('UNDE')
      CALL UPRNT1('CHAN$','TEXT')
      CALL UPRNT1(' $','TEXT')
      CALL UPRNT1('SYM$','TEXT')
      CALL USET('NOUN')
      CALL USET('NSYM')
      XPOS1  = XPOS + 1.00
      DO 30 IC = 1,8
         S     = IC
         IF (IC .GT. 6) S = S + 1.0
         YPOS  = YPOS - 4.0*YNUMDY
         YPOS1 = YPOS + 1.0*YNUMDY
         CALL UMOVE(XPOS,YPOS)
         CALL UPRNT1(CHAN(IC),'TEXT')
         CALL UPSET('SYMB',S)
         CALL UPEN(XPOS1,YPOS1)
   30    CONTINUE
C
C          Y-AXIS, LEFT
C
      XPOS   = 0.0
      YPOS   = 0.0
      YNUMX  = XPOS - YNUMDX
      YNUMY  = YPOS - YNUMDY
      CALL UPRINT(YNUMX,YNUMY,TENTHS(1))
      DO 50 IY1 = 1,10
         DO 40 IY2 = 1,9
            YPOS = YPOS + 0.0100
            CALL UMOVE(XPOS,YPOS)
            CALL UDRAW(YTMLN2,YPOS)
```

```
40        CONTINUE
        YPOS  = YPOS + 0.0100
        YNUMY = YPOS - YNUMDY
        CALL UPRINT(YNUMX,YNUMY,TENTHS(IY1+1))
        CALL UMOVE(XPOS,YPOS)
        CALL UDRAW(YTMLN1,YPOS)
50      CONTINUE
C
C          X-AXIS, TOP
C
      XPOS   = 0.0
      YPOS   = 1.0
      CALL UMOVE(XPOS,YPOS)
      CALL USET ('SOFT')
      CALL USET ('INTE')
      CALL UPSET('ANGL',90.0)
      XHORZ  = 0.1500 / YSIZE
      XVERT  = 0.1875
      CALL UPSET('HORI',XHORZ)
      CALL UPSET('VERT',XVERT)
      XNUMX  = XPOS + XNUMDX
      XNUMY  = YPOS + XNUMDY
      CALL UPRINT(XNUMX,XNUMY,RKSCAN)
      YPOS1  = YPOS - XTMLN1
      YPOS2  = YPOS - XTMLN2
      NXTICK = XLNGTH + 0.01
      CALL UPSET('SYMB',4.0)
      CALL USET ('NSYM')
      DO 80 IX1 = 1,NXTICK
         DO 60 IX2 = 1,9
            XPOS = XPOS + 0.1
            CALL UMOVE(XPOS,YPOS)
            CALL UDRAW(XPOS,YPOS2)
60          CONTINUE
         XPOS   = IX1
         XNUMX  = XPOS + XNUMDX
         RKSCAN = RKSCAN + SCNNPI
         CALL UPRINT(XNUMX,XNUMY,RKSCAN)
         CALL UMOVE(XPOS,YPOS)
         CALL UDRAW(XPOS,YPOS1)
         IF ((MOD(IX1,10) .NE. 0) .OR. (IX1 .EQ. XLNGTH)) GO TO 80
         YPLUS = 1.0
         DO 70 IPLUS = 1,9
            CALL UMOVE(XPOS,YPLUS)
            YPLUS = YPLUS - 0.10
            CALL UPEN(XPOS,YPLUS)
70          CONTINUE
80       CONTINUE
      CALL USET ('HARD')
      CALL USET ('TEXT')
      CALL UPSET('ANGL',0.0)
C
C          CHANNEL/SYMBOL TABLE, RIGHT
C
      XPOS   = ENDPLT - 1.75
      YPOS   = 0.94
      CALL UMOVE(XPOS,YPOS)
      CALL UPRNT1('FLIGHT $','TEXT')
```

```
      CALL UPRNT1(CFLT,'TEXT')
      YPOS   =  0.8
      CALL UMOVE(XPOS,YPOS)
      CALL USET('UNDE')
      CALL UPRNT1('CHAN$','TEXT')
      CALL UPRNT1(' $','TEXT')
      CALL UPRNT1('SYM$','TEXT')
      CALL USET('NOUN')
      CALL USET('NSYM')
      XPOS1 = XPOS + 1.00
      DO 90 IC = 1,8
         S     = IC
         IF (IC .GT. 6) S = S + 1.0
         YPOS  = YPOS - 4.0*YNUMDY
         YPOS1 = YPOS + 1.0*YNUMDY
         CALL UMOVE(XPOS,YPOS)
         CALL UPRNT1(CHAN(IC),'TEXT')
         CALL UPSET('SYMB',S)
         CALL UPEN(XPOS1,YPOS1)
   90    CONTINUE
C
C          Y-AXIS, RIGHT
C
      YPOS   = 1.0
      XPOS1  = XLNGTH - YTMLN1
      XPOS2  = XLNGTH - YTMLN2
      YNUMX  = XLNGTH + 0.1250
      YNUMY  = YPOS   - YNUMDY
      CALL UPRINT(YNUMX,YNUMY,TENTHS(11))
      DO 110 IY1 = 1,10
         DO 100 IY2 = 1,9
            YPOS = YPOS - 0.0100
            CALL UMOVE(XLNGTH,YPOS)
            CALL UDRAW(XPOS2,YPOS)
  100       CONTINUE
         YPOS  = YPOS - 0.0100
         YNUMY = YPOS - YNUMDY
         CALL UPRINT(YNUMX,YNUMY,TENTHS(11-IY1))
         CALL UMOVE(XLNGTH,YPOS)
         CALL UDRAW(XPOS1,YPOS)
  110    CONTINUE
C
C          X-AXIS, BOTTOM
C
      XPOS   = XLNGTH
      YPOS   = 0.0
      DO 130 IX1 = 1,NXTICK
         DO 120 IX2 = 1,9
            XPOS = XPOS - 0.1
            CALL UMOVE(XPOS,YPOS)
            CALL UDRAW(XPOS,XTMLN2)
  120       CONTINUE
         XPOS = XLNGTH - IX1
         CALL UMOVE(XPOS,YPOS)
         CALL UDRAW(XPOS,XTMLN1)
  130    CONTINUE
C
C       LABEL TIME AXIS WHERE TIMES ARE AVAILABLE AND AT LEAST SOME
```

```
C          DATA IS GOOD
C
      CALL USET ('SOFT')
      CALL UPSET('ANGL',90.0)
      XHORZ  = 0.1500 / YSIZE
      XVERT  = 0.1875
      CALL UPSET('HORI',XHORZ)
      CALL UPSET('VERT',XVERT)
      TIMEY  = -XHORZ*9.0
      DO 160 NS = ISCSTR,NSCN
         IF (MOD(KSCAN(NS),NSCNPI) .NE. 0) GO TO 160
         DO 140 I = 1,8
            IF ((PHI(NS,I) .GT. 0.0) .AND. (PHI(NS,I) .LT. 1.0))
     1           GO TO 150
  140       CONTINUE
         GO TO 160
  150    XPOS  = (KSCAN(NS) - NSTART) / SCNNPI
         TIMEX = XPOS + XNUMDX
         CALL UMOVE(TIMEX,TIMEY)
         WRITE(CHR,1010) ITIME(NS,1)
         WRITE(CMN,1010) ITIME(NS,2)
         WRITE(CSC,1010) ITIME(NS,3)
         CALL UPRNT1(CHR,'TEXT')
         CALL UPRNT1(CLN,'TEXT')
         CALL UPRNT1(CMN,'TEXT')
         CALL UPRNT1(CLN,'TEXT')
         CALL UPRNT1(CSC,'TEXT')
  160    CONTINUE
      CALL USET ('HARD')
      CALL UPSET('ANGL',0.0)
C
C       PLOT DATA FOR EACH CHANNEL WHEN   0.0 < PHI < 1.0
C
C          CYCLE ON CHANNEL
C
      DO 210 IC = 1,8
         S     = IC
         IF (IC .GT. 6) S = S + 1.0
         XPOS  = -0.1
         YPOS  =  0.0
         NGOOD = -1
         CALL USET ('NSYM')
         CALL UPSET('SYMB',S)
         CALL UMOVE(XPOS,YPOS)
C
C          FIND FIRST GOOD DATA VALUE FOR THIS CHANNEL AND PLOT SYMBOL
C
         DO 170 NS = ISCSTR,NSCN
            IF (IC .EQ. 8) IIC = ICH8(NS)
            IF ((IC .EQ. 8) .AND. (IIC .EQ. 7)) GO TO 170
            N = NS
            IF ((PHI(NS,IC) .GT. 0.0) .AND. (PHI(NS,IC) .LT. 1.0)) THEN
               GO TO 180
               END IF
  170       CONTINUE
         GO TO 210
  180    XPOS  = (KSCAN(N) - NSTART) / SCNNPI
         NGOOD = NGOOD + 1
```

```
          CALL UPEN(XPOS,PHI(N,IC))
C
C           PLOT REST OF GOOD DATA FOR THIS CHANNEL
C
          NSP1   = N + 1
          CALL USET('LNUL')
          DO 200 NS = NSP1,NSCN
             IF ((PHI(NS,IC) .LE. 0.0) .OR. (PHI(NS,IC) .GE. 1.0))
     1            GO TO 190
             NGOOD = NGOOD + 1
             IF (IC .NE. 8) THEN
                IF (((NS+1) .LE. NSCN) .AND.
     1              ((PHI(NS+1,IC) .LE. 0.0) .OR.
     2               (PHI(NS+1,IC) .GE. 1.0))) CALL USET('LSYM')
                IF (((NS+1) .LE. NSCN) .AND.
     1              ((KSCAN(NS+1) - KSCAN(NS)) .NE. 1))
     2                CALL USET('LSYM')
                IF ((MOD(NGOOD,5) .EQ. 0) .AND.(NGOOD .NE. 0)) THEN
                   CALL USET('LSYM')
                   NGOOD = 0
                   END IF
               ELSE
                   IIC  = ICH8(NS)
                   IF (IIC .EQ. 7) GO TO 190
                   NIIC = 7
                   IF ((NS+1) .LE. NSCN) NIIC = ICH8(NS+1)
                   IF (NGOOD .GE. 1) THEN
                      IF (NIIC .EQ. 7) CALL USET('LSYM')
                      IF (((NS+1) .LE. NSCN) .AND.
     1                   ((PHI(NS+1,IC) .LE. 0.0) .OR.
     2                    (PHI(NS+1,IC) .GE. 1.0)))  CALL USET('LSYM')
                      IF (((NS+1) .LE. NSCN) .AND.
     1                    ((KSCAN(NS+1) - KSCAN(NS)) .NE. 1))
     2                      CALL USET('LSYM')
                      END IF
                   END IF
             IF (((KSCAN(NS) - KSCAN(NS-1)) .NE. 1) .OR.
     1            (PHI(NS-1,IC) .LE. 0.0) .OR.
     2            (PHI(NS-1,IC) .GE. 1.0)) THEN
               NGOOD = 0
               CALL USET('NSYM')
               END IF
             IF (NS .EQ. NSCN) THEN
               CALL USET('LSYM')
               IF (((KSCAN(NS) - KSCAN(NS-1)) .NE. 1) .OR.
     1              (PHI(NS-1,IC) .LE. 0.0) .OR.
     2              (PHI(NS-1,IC) .GE. 1.0)) CALL USET('NSYM')
               END IF
             XPOS  = (KSCAN(NS) - NSTART) / SCNNPI
             CALL UPEN(XPOS,PHI(NS,IC))
             IF ((IC .EQ. 8) .AND. (NIIC .EQ. 7)) GO TO 190
             CALL USET('LNUL')
             GO TO 200
  190        NGOOD = -1
             CALL USET('NSYM')
  200        CONTINUE
  210     CONTINUE
      XPOS = XPLT
```

```
      YPOS = XBMRGN
      CALL UMOVE(XPOS,YPOS)
      CALL UERASE
      IF (INDEX .EQ. NPASS) CALL UEND
      GO TO 999
  900 NSCN1 = NSCAN(NPASS)
      WRITE(6,1020) XLNGTH,NSCN,NSCN1,(NS,KSCAN(NS),NS=ISCSTR,NSCN1)
      CALL UERASE
  999 RETURN
 1000 FORMAT(I4,1H$)
 1010 FORMAT(I2,1H$)
 1020 FORMAT(1H1,/,27H THE X LENGTH OF THE PLOT =,1P,E12.4,//,
     1       42H THE INDEX OF THE LAST VALID SCAN NUMBER =,I5,//,
     2       42H THE INDEX OF THE LAST       SCAN NUMBER =,I5,//,
     3       30H THE ARRAY OF SCAN NUMBERS IS:,/,
     4       (I5,I8,/))
      END
```

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President

10/24/88

I certify that this quarterly report was received and accepted on 7 Nov 1988 and it
(Date)
accurately represents the work performed.

SIGNED Michael D King

TITLE Physical Scientist